POWER PLANT ENGINEERING

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Power Generation for Wire Making

ROEBLING PLANTS AT TRENTON, N. J., EMPLOY MODERN COAL AND ASH HANDLING EQUIPMENT; COOLING TOWERS INTERESTING FEATURES OF INSTALLATIONS

IN MANY RESPECTS power may rightfully be regarded as the life blood of all industry, and as industries expand so must the available sources of power be made capable of meeting the ever increasing demands. This is well exemplified in the case of both the Buckthorn and the Elmer St. (Trenton, N. J.) works of the John A. Roebling Sons Co, where, due not only to insufficient capacity but also obsoleteness of equipment, it recently became necessary to replace two old power houses with stations more modern and more capable of meeting the requirements of the institution.

Part of this rehabilitation was inaugurated as early as 1913, but it was not until a comparatively short while ago that the final work on both the Buckthorn and the Elmer St. stations was completed.

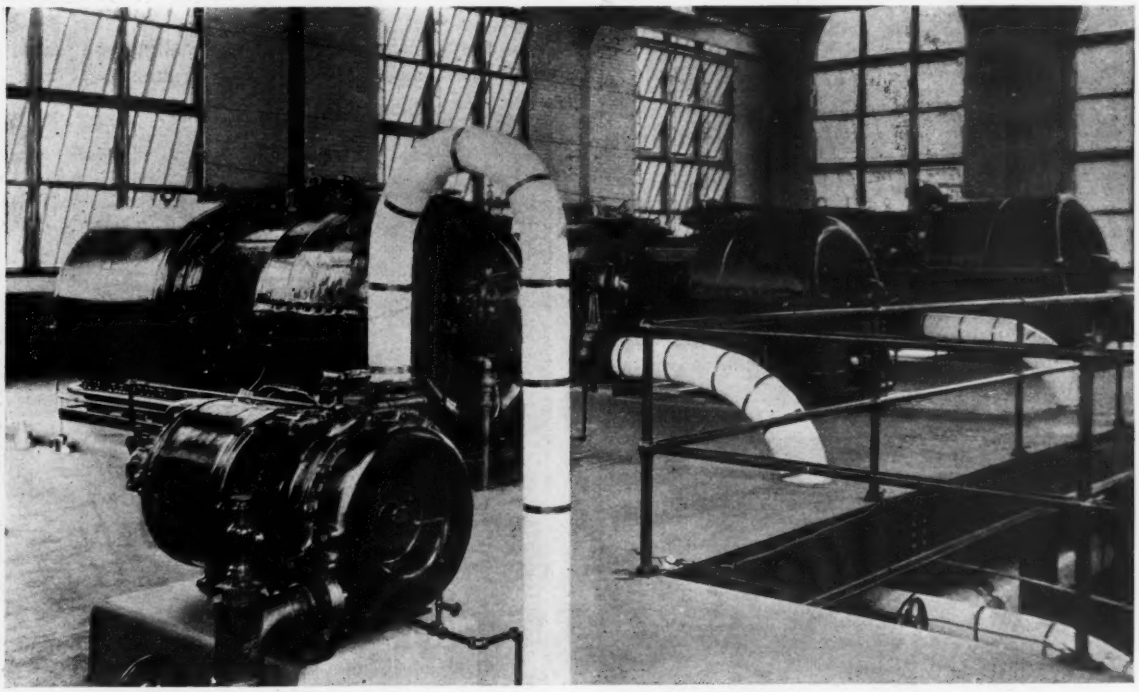


FIG. 1. GENERATING UNITS AT ELMER ST. STATION

THE ELMER ST. STATION

PRIMARILY this plant, which is the larger of the two, is intended to supply electric energy for light and power to the Elmer and the Canal Sts. rope shops and the Elmer St. wire mills, and while the Buckthorn Works station is essentially of the isolated type, this power house embodies many features characteristic of the modern central station. Principally among these are the coal and ash handling equipment, the remote controlled electrical equipment, the condensing apparatus and the cooling tower installation, although on account of like local conditions, cooling towers are also employed at the Buckthorn Works.

The form of the structure, its location with reference to the Works proper, and the general arrangement of equipment, are as shown in Fig. 13. The power house is a substantial single-story L-shaped building of steel con-

crete and brick construction, and as will be noted consists of a boiler room having overall dimensions of

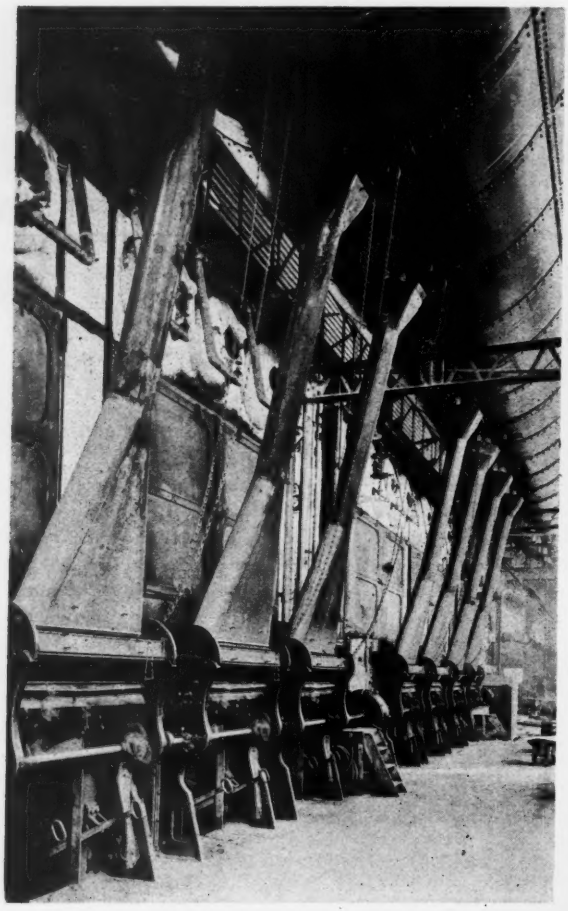


FIG. 2. GENERAL VIEW OF FIRING AISLE, ELMER ST. PLANT

approximately 165 by 50 ft. and an adjoining turbine room having a length of about 80 ft. and a width of nearly 60 ft.

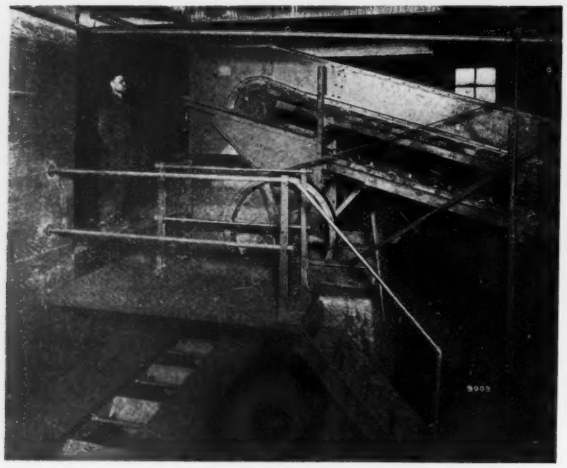


FIG. 3. SECTION OF APRON CONVEYOR, CRUSHER AND MAIN CONVEYOR AT ELMER ST.

In the boiler room are three batteries of steam generating units each consisting of two 600-hp. Babcock & Wilcox water-tube boilers equipped with B. & W. superheaters and Wetzel mechanical stokers. Steam is ordinarily generated at a pressure of 150 lb. gage, but before

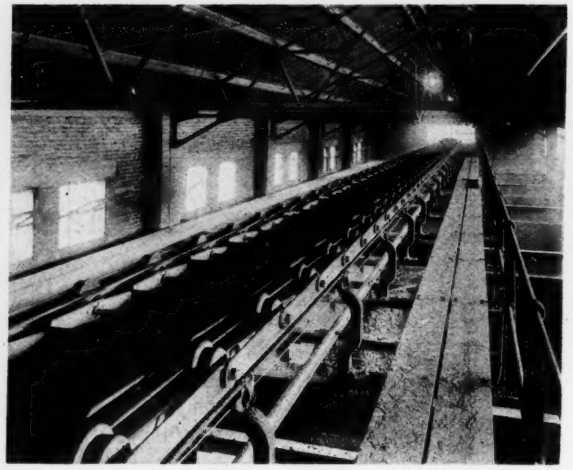


FIG. 4. UPPER RUN OF MAIN CONVEYOR AT ELMER ST. PLANT

being delivered to the headers is superheated 150 deg. F., thereby giving a working temperature of approximately 500 deg. F.

In this plant, the coal and ash handling equipment is of the most modern and complete mechanical carrier

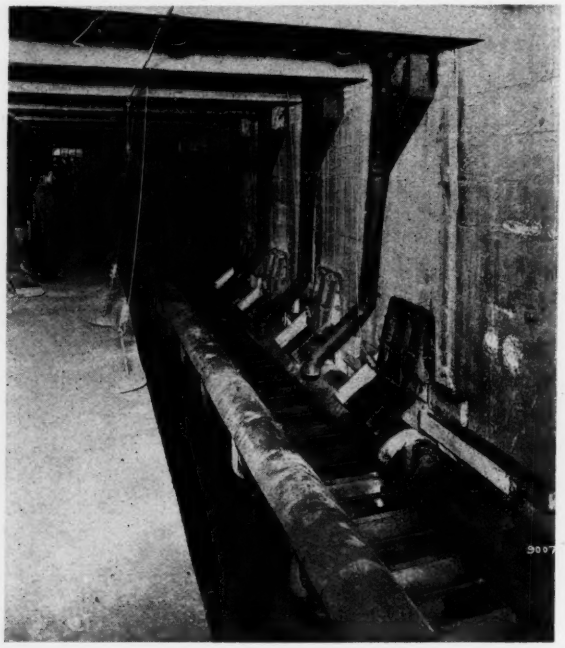


FIG. 5. LOWER RUN OF MAIN CONVEYOR INSTALLED AT ELMER ST.

type, built by the Link Belt Co. The cars in which the coal is delivered are run onto a spur track laid at an angle of approximately 20 deg. with the outside boiler room wall, and so placed as to span a double ¼-in. steel plate receiving hopper which, through the medium of

a double reciprocating feeder having ⅜-in. steel feeder plates, about 34 in. wide and 6 ft. long, and operated by a 5-hp. electric motor, feeds the coal to the apron conveyor shown in Fig. 3.

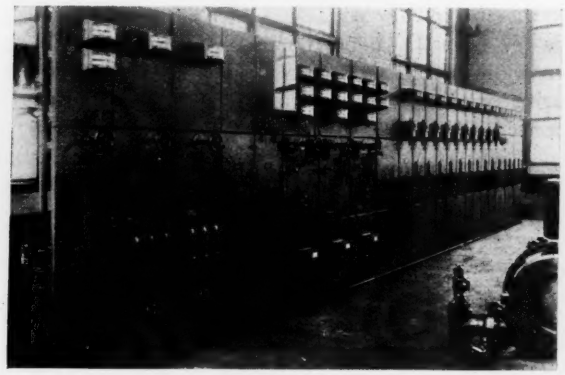


FIG. 6. THE ELMER ST. SWITCHBOARD

Reciprocating motion of the feeder is secured by means of an eccentric with a throw adjustment of from 4½ to 6 in. and driven by a countershaft running at a

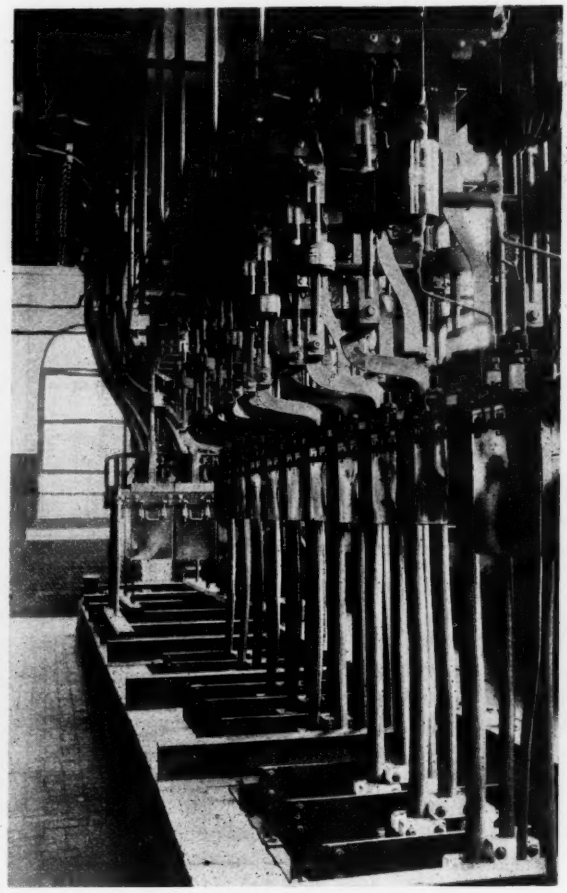


FIG. 7. SWITCHING EQUIPMENT AT ELMER ST.

speed of 25 r.p.m., which is connected to the motor through an intermediate countershaft by spur gears.

The apron conveyor has 30-ft. centers and carries the coal to a standard crusher equipped with two rolls, each 24 in. long and 28 in. in diameter, and operated at a speed of 56 r.p.m.; this crusher is driven in conjunction with the apron conveyor by means of a 15-hp. electric motor and has one set of bearings fitted with relief

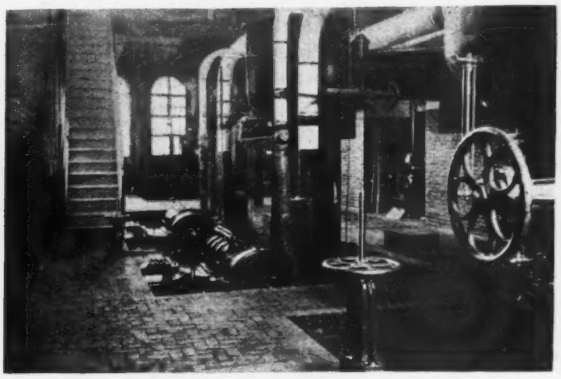


FIG. 8. SMALL CONDENSERS INSTALLED AT ELMER ST. PLANT

springs in order to allow the backward movement of one of the rollers, and thereby avoid damage to the machine in the event of any foreign substance finding its way between the rolls.

Upon being discharged by the crusher, the coal falls directly into the carrier buckets and is elevated and dis-

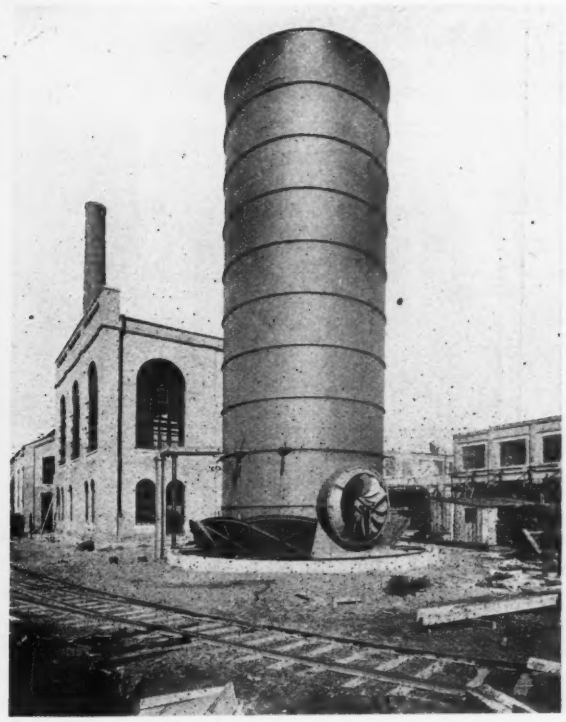


FIG. 9. COOLING TOWER USED AT BUCKTHORN PLANT

tributed along the horizontal run above the bunkers, a tripper which tilts the buckets at any desired point being provided for the purpose. From the bunkers the coal is fed by gravity through spouts to the stoker hoppers; gate valves operated from the boiler room floor by chains are employed to control the rate of feed.

Between the two strands of the heavy malleable iron chain of the carrier are suspended 24 by 24 in. malleable-iron buckets fitted with overlapping lips to prevent the spillage of coal or ashes during the process of filling. The coal is delivered to the buckets below the boiler room floor and is elevated 61 ft. to a horizontal run of approximately 131 ft., after which the bucket is emptied and returned to the lower horizontal run, when, if so desired, it may either be returned for reloading with coal or filled with ashes through spouts leading from the pits below the various boilers. When ashes are handled, these are discharged into a separate receiving bin from local city system through a 16-in. main and is delivered through an 8-in. line to a Cochrane open feed-water heater and purifier, having a water heating capacity of 108,000 lb. per hour.

Under ordinary conditions of operation the boilers are fed by a 270-gal. per minute Alberger centrifugal pump direct connected to and driven by a Curtis steam turbine, and while this at the present time is, except for number 10½ Sellers injectors with which each boiler is equipped, the only boiler feed pumping unit installed, a second set of like size and make has been provided for.

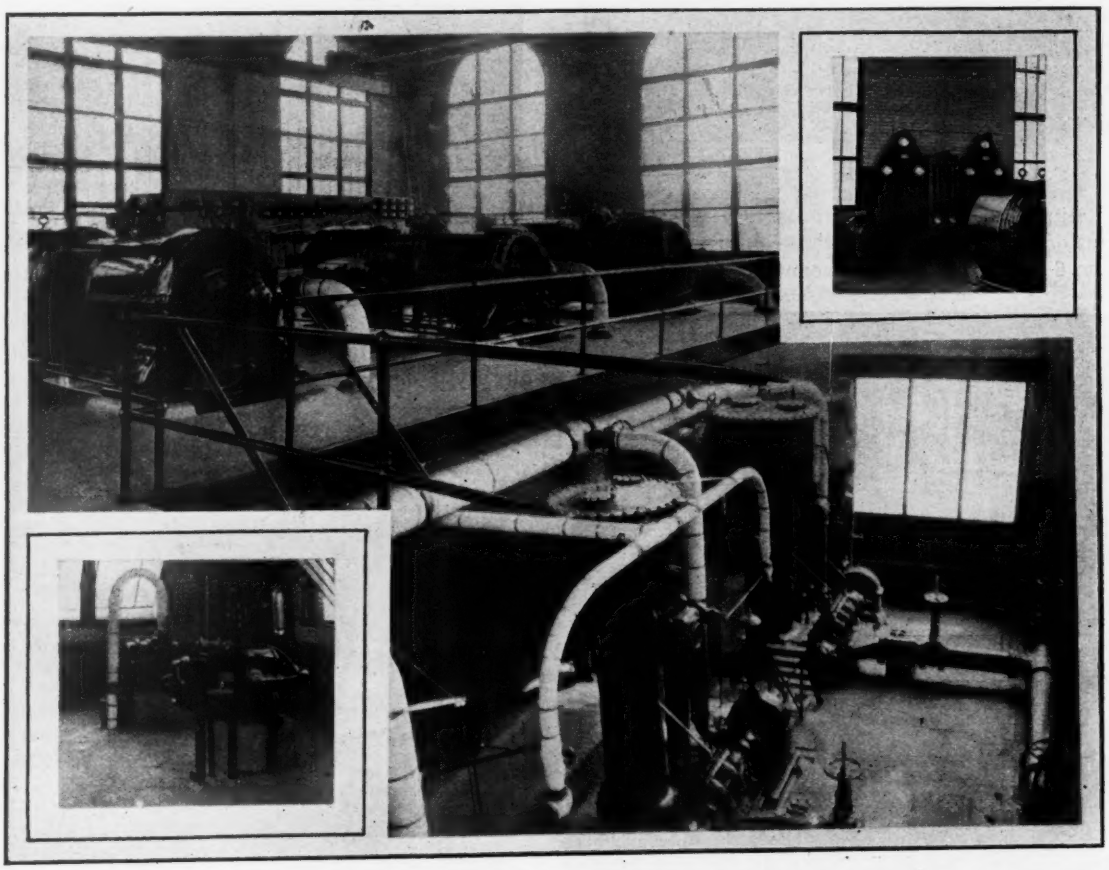


FIG. 10. GENERATING UNITS, CONDENSERS, EXCITERS AND GAGE BOARD INSTALLED AT BUCKTHORN WORKS PLANT

where they are removed into cars through chutes provided for that purpose.

On the horizontal runs of the carrier, the chain rollers travel over T rails supported by cast-iron chairs, which in turn are attached to the supporting steelwork on the upper run and to the concrete floor of the tunnel on the lower run. Cast-iron chairs attached to the casings enclosing the vertical runs are used as supports for double T rails between which the chain rollers of the ascending and descending runs travel.

The carrier is driven by a 10-hp. motor through the medium of a series of gears arranged to eliminate the irregular motion ordinarily accompanying long pitch chains. As a result, the motion of the carrier is uniform.

Water for boiler feed purposes is taken from the

High-Pressure Piping

Steam, as shown in the accompanying illustration, is delivered through 8-in. branch leads to an 18-in. main header carried along the top of the boilers and fitted with Van Stone joints and Chapman steel gate valves. At a point near the center of the header a 12-in. primary distribution line is connected and carried into the turbine room in the manner indicated in Fig. 14 the scheme of connection being such as to utilize the terminals of this line as a turbine room header which for general appearances and economy of space has been placed below the turbine room floor. The branch leads all of which are fitted with Chapman valves, are 6 and 8 in. in diameter for the 1000 and 2000-kw. turbine sets respectively, 2½ in. for the condensing units and

6 in. for two 1500-gal. pumps, equipment located in a pump house adjacent to the turbine room. Two-and-one-half and 3-in. lines supply steam to the air pumps employed in conjunction with the condensers.

Generating Units and Auxiliaries

Essentially the prime mover equipment consists of three 480-v. 60-cycle three-phase General Electric Co.'s turbine driven alternating-current generators, two with a rating of 1000 kw. each and one with a rating of 2000 kw. The smaller of these sets is designed and arranged for condensing operation only while the 2000-kw. unit may be run either condensing or noncondensing as required.

Part of the condensing equipment installed at this plant is shown in Fig. 8. For the 2000-kw. generating set there has been provided a 42-in. Alberger Pump and Condenser Co.'s Spiroflo jet condenser, with 12-in. re-

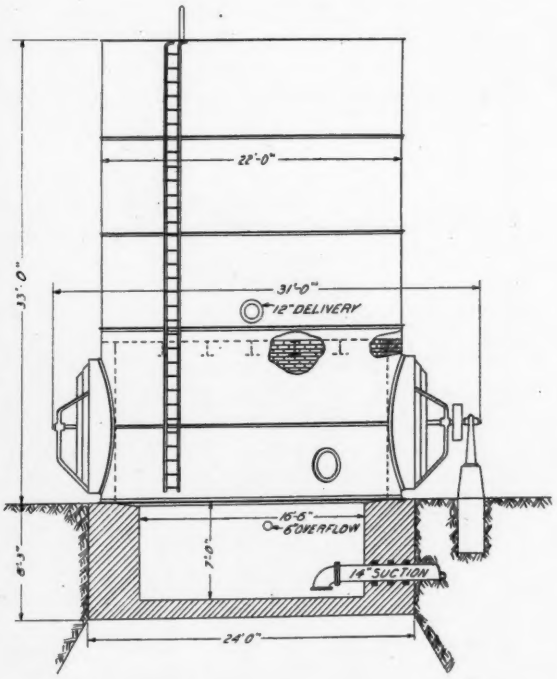


FIG. 11. ALBERGER COOLING TOWER USED IN CONJUNCTION WITH BUCKTHORN WORKS PLANT

moval pump driven through the medium of gear transmission by a 30-in. Alberger Curtis turbine, and a 12 by 22 by 18-in. steam-driven vacuum pump of the reciprocating type, while for each of the smaller units a 30-in. Spiroflo jet condenser with 12-in. three impeller removal pump driven by a 24-in. Alberger-Curtis turbine and an 8 by 16 by 12-in. vacuum pump has been installed. The rated capacity of each of the two 30-in. condensers is 20,000 lb. of steam per hour and of the 42-in. condenser 36,000 lb. of steam per hour, the vacuum being maintained at 1 lb. absolute with injection water at 75 deg. F. or when operating with a cooling tower and the same amount of steam handled an absolute pressure of 1½ lb. can be maintained with an atmospheric wet bulb temperature of 68 deg. F.

After having been utilized by the 2000-kw. turbine the steam may be discharged either into the connecting condenser or if required for heating purposes, it may be passed through an 18-in. Cochrane multi-port exhaust valve and into a main of like size which serves the heating system. Exhaust from the various turbine room auxiliaries is delivered to a 10-in. line carried parallel to the main steam header and after being increased to 12 in. into the boiler room when it connects with the heater in order to utilize this steam for the heating of the boiler feed water.

Condensing Water Supply

Water for condensing purposes is taken from the Delaware & Raritan Canal. Due, however, to the fact that the canal is closed in winter, two cooling towers

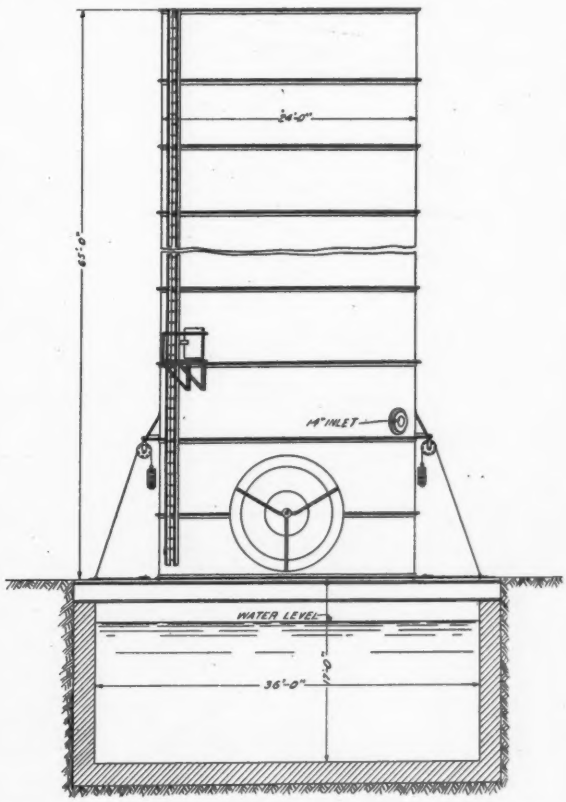


FIG. 12. TWO-FAN COOLING TOWER INSTALLATION AT ELMER ST.

of Alberger Pump and Condenser Co.'s make have of necessity been installed. These are each 30 ft. in diameter, 65 ft. high and are provided with 12-ft. fans, each driven by a 60-hp. electric motor of the induction type. The arrangement of this equipment is as shown in Figs. 13 and 14.

A 24-in. line connecting with the well below the cooling towers is carried below the floor of the turbine room basement and serves the various condensing units, the one used in conjunction with the 2000-kw. set through the medium of a 14-in. branch and each of the smaller ones through a 12-in. branch. Leads of like dimensions are used for the handling of the discharge, all of which,

however, terminate in a 24-in. main which, in turn, is so connected as to enable the operators to pass the water through the towers for the purpose of re-cooling or back into the canal.

The basin below the cooling towers has a capacity of 135,000 gal. and is supplied with water through two 30-in. cast-iron intake lines, each properly screened to guard against the entrance of leaves, trash and debris.

This basin is also used as a source of supply for fire protection purposes.

Electrical Equipment

As stated above, the prime mover equipment consists of one 2000-kw. and two 1000-kw. General Electric turbo-alternator sets. Each of these generators is wound for 480 v. and delivers current at 60 cycles, three phase to the control and distribution board shown in Fig. 6. All of the high-voltage switches are located in the basement of the turbine room directly below the switchboard and are under remote control.

Ventilation for the generator windings is secured through ducts connecting with the outside. The duct used in connection with the large unit has dimensions of 2 ft. 11 in. by 2 ft. 1 in., while those serving the smaller machines are 21 by 23 in. in section, thus providing 0.4375 sq. in. of duct section for each kilowatt rating for the 2000-kw. generator and 0.483 sq. in. of duct section per kilowatt rating for each of the two 1000-kw. sets.

The Buckthorn Plant

This station, as its name implies, serves the Buckthorn Works, and while its rated capacity is somewhat less than that of the Elmer St. power house, it is built and operated along similar lines. In fact, the same make of equipment is installed in both plants.

Steam generating, and electric generating and control equipment are housed in separate buildings. The boiler house embodies no features of particular interest

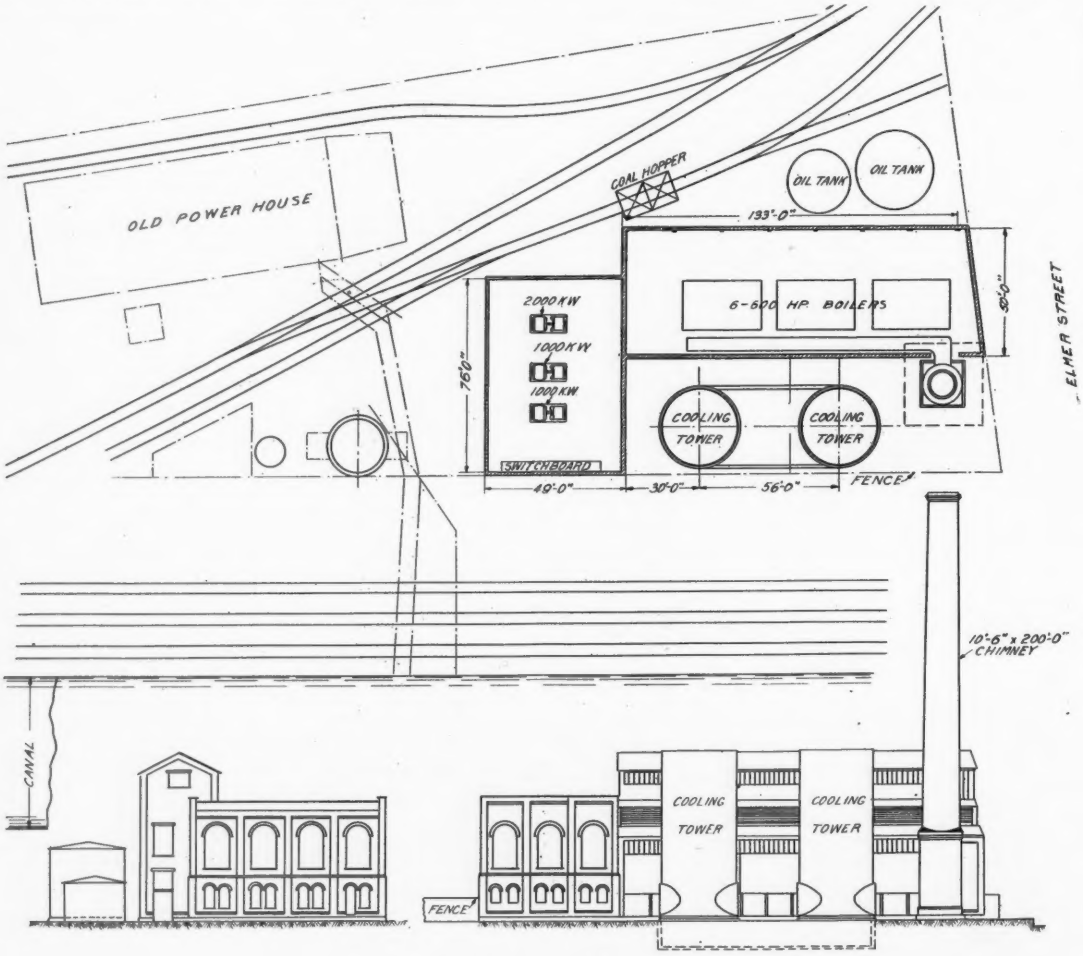


FIG. 13. GENERAL LAYOUT OF ELMER ST. PLANT

other than the four 500-hp. Babcock & Wilcox water-tube boilers, each of which, as in the case of the boilers in the Elmer St. plant is equipped with Wetzel mechanical stokers.

Coal and ash handling is entirely manual.

Steam which is used not only for the operation of the prime movers and auxiliary equipment, but also for heating and some manufacturing processes, is ordinarily generated at 150 lb. gage and is delivered in a saturated condition to a 16-in. extra-heavy header which serves, by means of an 8-in. branch, two 750-gal.-per-minute and

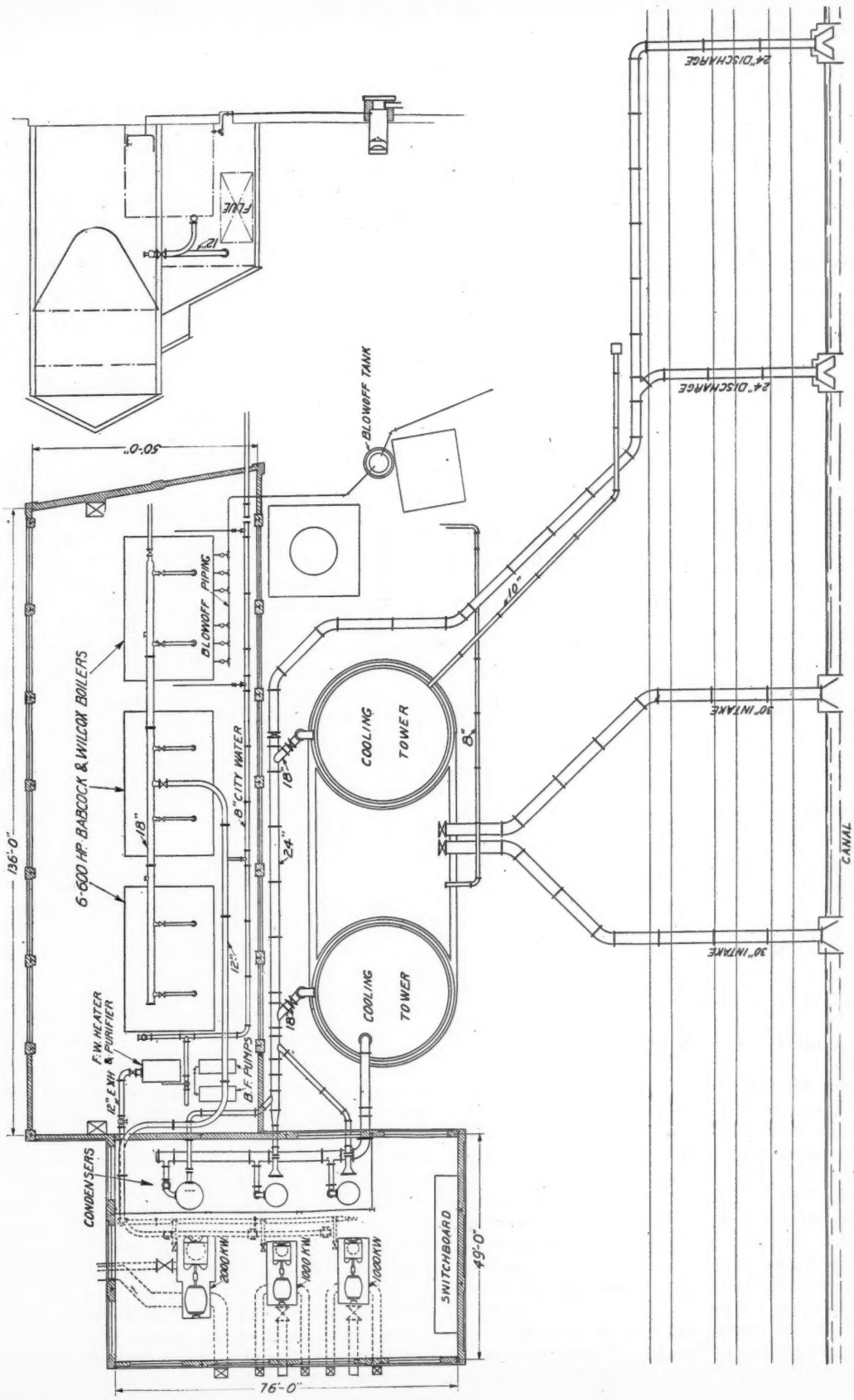


FIG. 14. DETAILED LAYOUT OF EQUIPMENT AT ELMER ST.

one 1500-gal.-per-minute pumps and through the medium of a 10-in. extra-heavy line, all of the requirements of the main power house.

Although in size somewhat smaller, the architectural features of the plant resemble those of the one located at Elmer and Canal Sts. It is of steel, concrete and brick construction throughout and consists primarily of the basement where are located the condensers and their auxiliary equipment, and the floor above where are found the three main generating units, the exciters and the switchboard.

Generating Equipment and Auxiliaries

Three 480-v., 60-cycle three-phase General Electric alternating current generating units have been here installed. One of these is rated at 1000 kw., while the other two have a capacity rating of 500 kw. each.

The steam service line for these machines consists of a 10-in. extra-heavy header, provided with 4½-in. branches for the 500-kw. units and an 8-in. extension terminating in a 6-in. lead for the large machine and a 4-in. branch serving some of the condenser auxiliaries. A 10 by 10 by 3 by 3-in. tee inserted at about the center of the 10-in. section of the header provides means for supplying steam to the two small condenser pump turbines and their air pumps.

Two of the condensers and part of their auxiliary equipment are shown in Fig. 10. Those employed in conjunction with the small units are each of the Alberger Pump & Condenser Co.'s Spiroflo type equipped with 10-in. removal pump driven by and direct connected to a 24-in. Alberger-Curtis turbine and a 6 by 14 by 10-in. dry vacuum pump, while for the 1000-kw. set there is found a 30-in. Spiroflo jet condenser fitted with a 12-in. three-impeller removal pump, also operated by a 24-in. Alberger-Curtis turbine; the vacuum pump used in conjunction with this set has dimensions of 8 by 16 by 12 in.

As like conditions prevail at this plant as at the Elmer St. station, cooling towers are installed here also, one of the combined forced and natural draft type, and one of forced draft only, each with a diameter of 24 ft. and a height of 65 ft. The two small condensers, although having a combined capacity rating of 22,000 lb. of steam per hour, are capable of handling 24,000 lb. per hour and maintaining an absolute pressure of 2 lb. with injection water at 75 deg. F. When operating with the cooling tower, the same amount of steam handled, and with an atmospheric wet bulb temperature of 68 deg. F. an absolute pressure of 1½ lb. may be maintained.

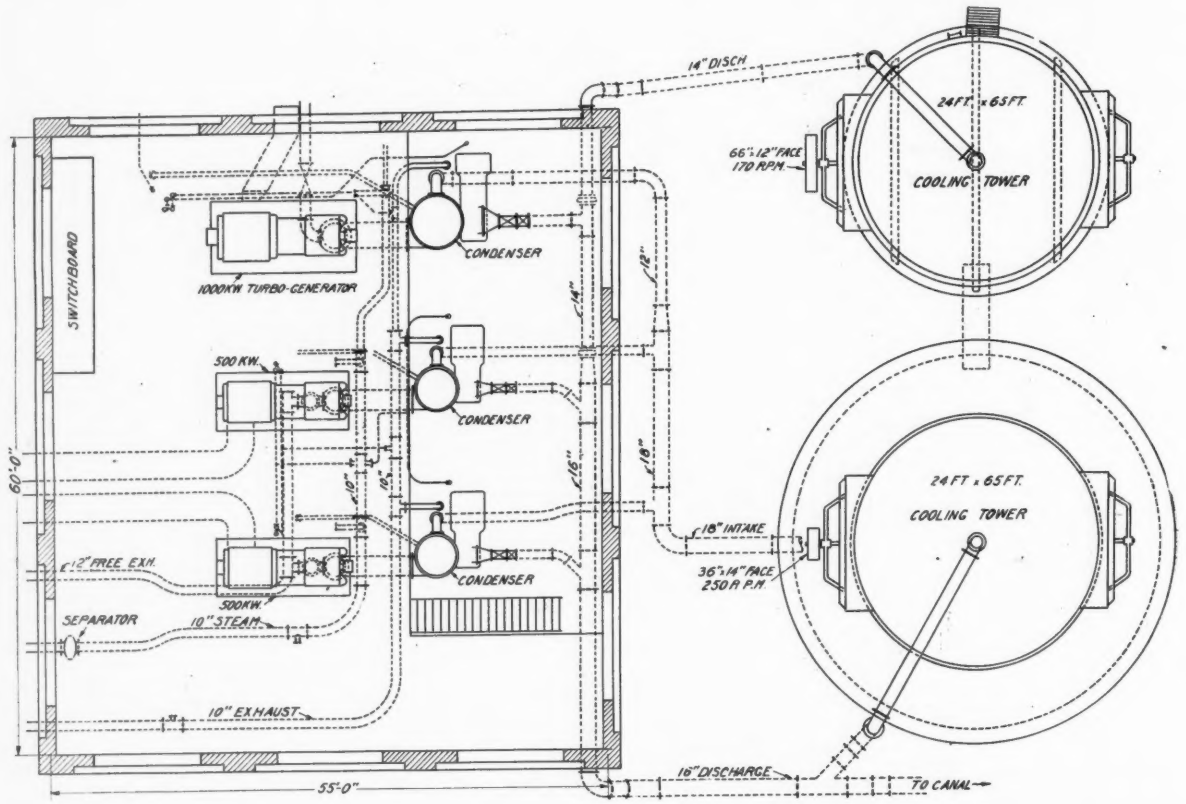


FIG. 15. PLAN OF BUCKTHORN PLANT SHOWING COOLING TOWERS AND WATER CONNECTIONS

Condenser pump drive turbine, and air pumps exhaust into a common header carried parallel to the high-pressure steam header and made up of 10 and 6-in. sections carried through the power house and into the boiler house, where this line, which is fitted with a 10-in. Cochrane back pressure valve, connects with an open feed water heater. Each of the vacuum pump exhaust lines are 1½ in. in diameter, while those of the condenser pump turbines are 5 in.

Improving Factory Steam Plants---V

TEST TO DETERMINE PROPER DIVISION OF COSTS; SCHEDULE OF OPERATION FOR POWER DEPARTMENT. BY H. A. WILCOX

AFTER the report as printed in the Oct. 15 issue was submitted, a check test, number 7, was run with the following results:

Boiler test number seven—Supplementing report dated May 4, 1916. Object—A test to determine the steam used by the Cotton Department of the —— —— Co., for the purpose of apportioning the charges for coal, operation, etc., between the Cotton and the Woolen Departments. During the test, the Woolen Department was entirely shut down and the Cotton Department was the sole user of steam, with the exception of the fire pump which will be considered under "Remarks."

DATA

FEED WATER measured by a — meter; coal weighed out in about 250-lb. lots as fired; flue gas analysis made every half hour; readings of feed water meter, steam pressure, feed water temperature, and draft taken every 15 min. All readings taken every half hour. All fires were cleaned previous to running the test. Blowoff pipes not blanked. No special instructions to firemen. Fires brought to the same level at the beginning and end of the test. Water level in the boilers determined by strings and measurements at the beginning and brought to the same level at the end of the test. Coal consisted of about equal parts of New River, Pocahontas, and Long Branch. For data on boilers, see report dated May 4, 1916.

RESULTS

DATE OF TEST	May 15, 1916
Duration of test (hours)	6
Time of test	12 mdt. to 6 a. m.
Weather	Rain
Av. steam pressure (pounds per sq. in.)	109.5
Av. feed water temperature (deg. F.)	195.5
Av. temperature of air in boiler room (deg. F.)	63.2
Av. temperature of flue gases (deg. F.)	630.4
Av. draft in ash pit (inches of water)	0.13
Av. draft over fire (inches of water)	0.26
Av. draft in flue (inches of water)	0.38
Av. flue gas analysis (per cent by volume)	
CO_2—8.65 0—10.83 CO—0.11 Total	19.59
Analysis of coal (per cent):	
Kind, semi-bituminous, S	0.75
Volatile	19.11
Carbon	73.28
Ash	4.41
Moisture	3.20
B.t.u. dry	15,028

Coal assumed to have 4.43 per cent oxygen and 4.12 per cent hydrogen, for the purpose of figuring the heat balance. Coal assumed to have 14,650 B.t.u. per pound as fired.

1.	Total water evaporated, lb	71,480
2.	Total coal as fired, lb	9,471.5
3.	Actual evaporation (corrected for quality and water level), lb	7.40
4.	Total equivalent evaporation from and at 212 deg. F., lb	74,318
5.	Equivalent evaporation from and at 212 deg. F., per lb. dry coal, lb	8.11
6.	Equivalent evaporation from and at 212 deg. F., per lb. coal as fired	7.85
7.	Equivalent evaporation from and at 212 deg. F., per sq. ft. heating surf. per hour, lb.	2.40
8.	Coal burned per sq. ft. of grate surface per hour, lb	14.35
9.	Boiler hp. per hour A.S.M.E. rating	358.9
10.	Per cent of builder's rated hp. developed per hour	71.78
11.	Air per pound of coal, from analysis of flue gases	18.42
12.	Theoretical air required per pound of coal	10.08
13.	Excess air supplied per pound of coal (per cent)	82.74
14.	Heat carried off by flue gases, B.t.u.	1653
15.	Heat taken up by water in boilers, B.t.u.	7609
16.	Heat radiated, B.t.u.	5388
17.	Total heat furnished per pound of coal, B.t.u.	14,650
18.	Per cent heat carried off by flue gases	11.28
19.	Per cent heat lost by radiation	36.78
20.	Per cent thermal efficiency of boilers	51.94

REMARKS

Assumed: Quality of steam, 98 per cent; barometer, 14.7 lb. per sq. in. The 20 by 11½ by 15-in. Worthington duplex fire pump was running all through the test. Ordinarily, this pump does not run as the two centrifugal pumps (motor driven), are sufficient to take care of all the water requirements. Owing to this fact, the amount of steam used by the fire pump should be deducted from the amount used by the Cotton Dep't. Readings of water pressure and strokes per minute of this pump were taken during the test and I estimate that 19 boiler horsepower should be deducted from the gross horsepower in order to get the net Cotton steam load. This would make the net average boiler horsepower used by the Cotton Dep't. (358.0—19) = 339.9 or practically 340 hp.

The average boiler horsepower developed in a series of six tests as shown above was 568.8 hp. All of these tests were run with both the Cotton and the Woolen Departments running full time. Comparative results appear in the table below:

1.	B.hp. per hour used by the Cotton Dep't. and Woolen Dep't. together	568.8
2.	B.hp. per hour used by the Cotton Dep't alone	340.0
3.	B.hp. per hour used by the Woolen Dep't. alone	228.8

4. Per cent of full load used by the Cotton Dep't. 59.77
5. Per cent of full load used by the Woolen Dep't. 40.23

At present the Cotton Dep't is charged with 90 per cent of the coal consumed, 90 per cent of the labor employed in connection with the boilers, and all of the water used in the boilers. The above test shows that the Cotton Dep't uses only about 60 per cent of the total output of the boilers. On the other hand, the Woolen Dep't is shut down from Saturday noon until Monday morning and the total output of the boilers during this time is used by the Cotton Dep't. Taking this fact into consideration, slight changes would be necessary. After making all due allowances for certain stand-by losses, the shafting load on the engine and overtime in the Woolen Dep't on Saturday and Sunday, I would recommend that the following division of charges be adopted for all steam costs between these two departments:

The Cotton Dep't should pay for the following:

65 per cent of the coal used under the boilers during the week.

65 per cent of the labor used in connection with the boilers.

65 per cent of all the feed water used in the boilers.

The balance of all charges to be assumed by the Woolen Dep't. Such items as rent, repairs, renewals, etc., do not come within the scope of this report and must be determined by the head office. In my opinion, the Cotton Dep't should not be obliged to pay for 65 per cent of the repairs or renewals on account of the fact that all reasonable repairs and renewals should be included in the rent paid by the Cotton to the Woolen Dep't. The above division of charges shall hold true for the part of the year when circulation is shut off. When heating becomes necessary, on account of the fact that the Woolen Dep't is more extensive than the Cotton Dep't and thus requires more steam for heating purposes, these charges should be changed so that the Cotton pays only 60 per cent of the above items and the Woolen 40 per cent. The change shall be made on the first of October and the first of May each year.

A very thorough inspection of boilers 2, 3 and 4 was made after the above tests were made, with the following results:

A number of tubes in each boiler were worn very thin and were liable to let go at any minute. The water column connections were broken off inside the front tube sheets and needed renewing. The tubes had considerable scale on them and there was an oily deposit in No. 4. The blowoff pipes were all in poor shape and the settings were full of holes and cracks, allowing a large amount of excess air to get in, as shown by the tests.

I am informed by the boiler insurance company that the maximum allowable pressure on the boilers will undoubtedly be reduced by 10 or 15 lb. next year, and that thereafter a cut will take place each succeeding year. I therefore wish to emphasize the fact that the installation of new boilers must be considered at once.

Both of my reports were submitted to the Powers-That-Be and the recommendations made were largely adopted. The division of charges was adopted, and I began to study operating conditions in order to improve them where possible. After careful study and experimenting the following schedule was put into effect for the operation of the Power Department:

(NAME OF PLANT)

DAILY LOG

WEATHER_____

TEMPERATURE 6 A.M.____ 6 P.M.____ IN BOILER ROOM

MO.	DAY	YEAR

MR._____ I HAVE CAREFULLY NOTED THE FOLLOWING TO-DAY

HOUR OPERATION OF BOILERS, ETC.

TIME	A.M. 6	7	8	9	10	11	NOON 12	1	2	3	4	5	6	7	8	9	10	11	P.M. 12	1	2	3	4	5	A.M. 6
NO. 1																									
NO. 2																									
NO. 3																									
NO. 4																									
ENGINE																									
FIRE PUMP																									
WATER PUMP NO. 1 - 50 HP.																									
WATER PUMP NO. 2 - 20 HP.																									
FEED WATER TEMP.																									

BOILER FEED BAILEY METER READING		POUNDS OF FEED WATER	NO. LOADS OF COAL HAULED TO BOILER RM.	TOTAL LBS. COAL HAULED TO BLR. RM.	EVAPORATION LB. COAL PR. LB. WATER	NO. LOADS OF ASHES REMOVED	MAX. STEAM PRESSURE	MIN. STEAM PRESSURE	AV. STEAM PRESSURE
A.M. 6	DAY						DAY		
P.M. 6	N'T						N'T		

METER	DEPT.	TIME	READING	KWH USED LAST 24 HRS.
CITY WATER-TOILET	COTTON			
CITY WATER-TUBS	COTTON			
CITY WATER-BOILERS	COTTON			
CITY WATER-PAINT SH.	WOOLEN			
CITY WATER-MULE RM.	WOOLEN			
CITY WATER-CARD RM.	WOOLEN			
CITY WATER-NILER RM.	WOOLEN			

COAL UNLOADED

CAR NUMBER	WEIGHT-LB.

METER	TIME	READING	KWH USED LAST 24 HRS.
A ELECT. POWER YARN DEPT.			
B ELECT. LIGHT YARN DEPT.			
C ELECT. POWER & LT. WHOLE PLANT			
ELECT. POWER & LIGHT-COTTON DEPT.		C-(A+B)=	

	TUBES BLOWN BOILER NO.	WATER COLUMN BLOWN DOWN BOILER NO	BOILERS BLOWN DOWN BOILER NO	TRY COCK'S TESTED BOILER NO.	TUBES SCRAPED BOILER NO.	BOILERS WASHED OUT BOILER NO	TOTAL NO. MEN WORKING IN POWER DEPT.
DAY							
NIGHT							

REPAIRS ON	
ENGINE	
BOILER	
GRATES	
WATER PUMP NO. 1 - 50 HP.	
WATER PUMP NO. 2 - 20 HP.	
FEED WATER PUMP	
FIRE PUMP	
MISCELLANEOUS	

MECHANICAL ORDERS ISSUED	
NUMBER	NATURE

REQUISITIONS ISSUED	
NUMBER	NATURE

REMARKS

PLACE HERE ANYTHING OUT OF THE ORDINARY, SUCH AS ACCIDENTS, BREAKDOWN, REGULAR MEN OUT, SAFETY VALVE BLOWN, ETC. — REVERSE SIDE OF THIS SHEET TO BE USED IF NECESSARY.

SIGNED_____

FIG. 1. FORM OF DAILY LOG USED IN POWER PLANT

Schedule for Maintenance and Operation of Power Department

Force

Master Mechanic—Head of and responsible for entire department.

Engineer or Head Fireman—Responsible for details of operation and maintenance of whole department.

Firemen

Ash-man

Coal-haulers

Under Engineer or Head Fireman.

Maintenance

The following operations should be carried out at

the direction of the Master Mechanic and under the supervision of the Engineer or Head Fireman, at the intervals specified.

1. Base of chimney cleaned every 3 months.
2. Flue cleaned every month.
3. Receiver tank thoroughly washed out every 3 months.
4. Hand dampers and damper regulator inspected every month.
5. All windows washed, inspected and repaired every month.
6. Walls, boiler tops, flue top, etc., cleaned every month.
7. Feed regulator valves inspected, cleaned and oiled every month.
8. Feed water meter checked for zero reading every week.
9. Each boiler thoroughly washed out once in 4 weeks.
10. Settings inspected for air leaks when boilers are washed out.
11. Combustion chamber cleaned out when boilers are washed out.
12. Bridge and side walls cleaned when boilers are washed out.
13. All tubes scraped once a week.
14. Brass work on boilers polished once a week.
15. Safety valves blown and steam gages checked up every Monday 11 a.m.

Operation

1. Water columns blown down 6:30 a.m. and 6:30 p.m. daily.
2. Water column try-cocks tested 7 a.m. and 7 p.m. daily.
3. Tubes blown with steam hose when each fire is cleaned.
4. Boilers blown down one gage 8 a.m. and 8 p.m. daily.
5. Chart on feed water meter changed and meter reading taken 6 a.m. and 6 p.m. daily.
6. Daily Log for preceding day's run filled out and handed to the Master Mechanic by Engineer or Head Fireman 10 a.m. daily.
7. Boiler fronts, feed piping, etc., brushed off 11 a.m. and 11 p.m. daily.
8. Engine, pumps, etc., to be regularly inspected and oiled at least once every half hour by Engineer or Head Fireman.

Firing

Upon starting a shift, each fireman shall look at his fires and put them in proper condition if they are not already so. The fires should be about 8 in. thick in the middle and should slope upward toward the side and bridge walls, being kept about 2 in. higher at these points than they are in the middle.

An endeavor should be made, by setting the individual boiler dampers, to maintain a draft of about 0.5 in. of water in the flue. This should correspond to about 0.3 in. over the fire and about 0.2 in. in the ash pit. The fireman on No. 1 and No. 2 boilers shall then, if the steam pressure is 90 lb. or better, start to clean his fires. When he has cleaned and rebuilt those under Nos. 1 and 2 the other fireman shall clean those under Nos. 3 and 4. All fires will be cleaned as specified hereafter.

Firing Method

After the fires are trimmed, the following system of firing shall be started and adhered to all day. Beginning with No. 1 boiler, coal shall be put on the left-hand side of each fire in rotation. After a lapse of 10 min. by the clock, the right-hand side of each fire shall receive coal in the same manner, and 10 min. later the left-hand sides shall again receive coal, and so on. Under normal load, about four *full* shovels of coal to each side should be sufficient to maintain an 8-in. fire, as specified above. The fireman should fire first along the side walls, then to the back, and afterward what is necessary in the middle. He should aim each shovel full for the lowest and lightest place. When he has finished firing, he should have spread a thin layer of fresh coal over the surface and no holes should be visible. Ordinarily the hard crust which forms on top of each fire should be broken with the rake every other time coal is put on. The crust should be broken from 3 to 5 min. before the coal is put on.

When there is an abnormal load or when one boiler is stopped, it may be necessary to fire each door oftener than the specified interval and to use six shovelfuls instead of four to each firing. In this case the crust should be broken just before firing. In case the steam pressure falls and continues to do so, it may be neces-

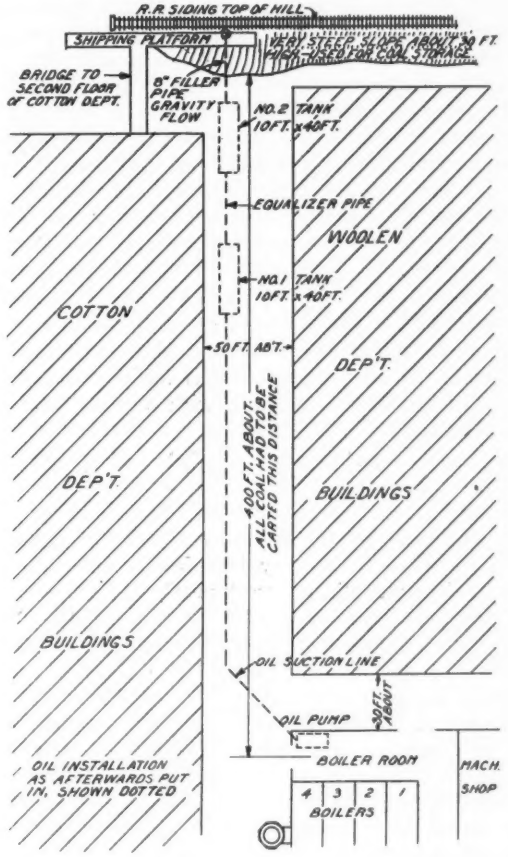


FIG. 2. GENERAL LAYOUT OF FACTORY PLANT

sary to put the slice bar under each fire twice and so break up any clinker that may exist. In any event, no two doors shall be opened at the same time to receive coal. While the fires of any boiler are being burned down for cleaning, that boiler shall for the time being be exempt from the above firing system. The grates shall be shaken at 11 a.m., 5 p.m., 11 p.m., 5 a.m. The fireman shall shake until hot coal begins to drop in the pit and at least five minutes shall intervene between the shaking of each grate.

Method of Cleaning Fires

One side of the fire to be cleaned, shall be burned low and then the clinkers shall be pulled out into a wheelbarrow, from this side. The clinker is quickly cleaned off from the bridge and side wall with the hoe. If this clinker is stuck on very hard, salt should be thrown on it rather than knocking it off with the slice bar. The grates should then be tipped so that small clinker and ash will fall off from them. Then the hot coals from the other half of the fire should be pushed over upon the clean grates and fresh coal should be put on. If the steam pressure is still up, the other half of the fire may be cleaned at once in the same way. When the whole fire has been cleaned, the ashes should be removed from the pit by the ash man and water should be at once put in the pit and should be kept there during the remainder of the shift.

It must be understood that the above firing system is adapted to normal operating conditions and should be varied slightly to conform with varying load and coal conditions.

To my readers, the above schedule and firing system may seem complicated and of little value; but I can only state that for several weeks, I stayed in this fireroom and saw that the system was carried out exactly as called for and the very best results were obtained with it. The men did not work nearly as hard as before and the steam pressure stayed up to the mark all the time. My readers will naturally ask, "How did you obtain the time intervals and the necessary number of shovelfuls of coal to put on?" I arranged the Orsat to work from all the boilers at once and then sat down and analyzed for CO_2 only. I counted the number of shovelfuls put on each time and noted the intervals between firings. After a short time, I found that the CO_2 stayed up between 10 and 12 if just so much coal was put on at certain intervals and then it was a simple matter to regulate these amounts and intervals so that the CO_2 stayed at a maximum all the time and this was of course the proper system to adopt. I had to analyze for O and CO occasionally in order to see that I was obtaining complete combustion at all times. The alternate firing principle was simply common sense for when fresh coal is put on a fire there is always a few minutes when this fire is doing no work and is cooler. Therefore if one side of a fire is always working, there is never a time when heat is not working under the boiler and the bright side of the fire will always assist in burning up the smoke produced by coaling one side.

The sample Daily Log accompanying this article needs but a word of explanation. Under "Hour operation of boilers, etc." the engineer draws a horizontal pencil line through the hours and opposite any machine or unit that was operating during those hours. Thus in the sample, all four boilers were run throughout the 24 hr., the engine ran from 6 a.m. to 1 p.m.; the fire pump ran from 5 p.m. to 8 p.m., etc. I have found that this form of log has proved very satisfactory in the different plants that I have handled.

A few more details will bring this article to a close. The plant ran very well for the next six months, and then a patch which had been put on No. 1 boiler began to leak, and it was found to be inadvisable to try to repair it any further. Two new boilers were at once ordered and were installed in place of Nos. 1 and 2. This operation required about six weeks, and the Cotton Dep't was shut down during the change. The new boilers were set higher from the grates than the old ones and proved to run very successfully after they were started. About a year later, owing to coal conditions, fuel oil was installed under these new boilers and a 250-hp. boiler was installed, also to burn oil, in place of boilers Nos. 3 and 4. I have roughly outlined the location of the oil tanks on the accompanying sketch, and it will be readily appreciated that a considerable saving in handling fuel was effected, as the long haul for the coal team was entirely eliminated. Furthermore, the boiler room is now being run by one man on each shift, and he has hardly enough to do to keep him busy. My connection with this plant was severed before the oil installation was entirely completed, so that I have never had an opportunity to test the plant in order to compare the economy of using oil in place of coal as fuel. I understand, however, that the oil is giving great satisfaction.

Major Hubert F. Miller, writing to Charles L. Dering from France under date of Aug. 29, says:

"Am now about six miles from Germany and can see plenty of German villages and one large city on the top of a nearby hill. Six miles seems a long way and it is quite some distance under certain conditions, but we hope to reduce it somewhat in the not distant future.

"We have done almost as well as we had hoped to do. We compared the modest official communique of the French with our newspaper reports and then blushed when we met a Frenchman. Now all has changed. We have made good so far, and can hold up our heads and smile. Privately we are willing to admit we are some guys. The divisions we have already tried have not failed in any particular. At great sacrifice of men, we made the Boche respect and even fear our troops as much as the best of our Allies. The German soldiers prefer to meet others than our soldiers and they have ample excuse for such preference. The Boches are not pleased because we are here. We have ruined another "quiet sector." It is going to be the most unquiet old sector in all France and Germany before very long. Our men have actually taken some of the largest German guns with the bayonet. A German machine gun wiped out one of our platoons, all but one man. He shot four of the gunners and bayoneted the other four. Little incidences of this kind have done much to earn the respect that the Germans are beginning to develop for our armies.

"I am aching to tell some things I know and to predict a few things."—Chicago Commerce.

Boiler Room Efficiency*

By A. H. Blackburn†

BOILER ROOM efficiency bears directly on the smokeless combustion of fuel. While smoke inspectors today may be said to have finished this work when they have succeeded in getting users to abolish the discharging volumes of black smoke from chimneys, if the user, in accomplishing this result, does not at the same time increase his boiler room efficiency, the inspector sooner or later is going to have to do his work all over again. Consuming smoke does not of necessity mean increased economy.

Analysis of Fuel

As the largest item of expense is fuel, the first consideration should be given to carefully buying the coal that will give the best results commercially. Coal giving the highest boiler room efficiency may not commercially be the most economical—the volatile grade of coal selling at a lower price giving 68 to 70 per cent of efficiency may work out better than a higher priced coal giving 75 per cent efficiency. Coal should, therefore, be bought on price and a guaranteed analysis, with clause covering reduction or advance in price according to the quality actually supplied, etc. The Bureau of Mines at Washington, D. C., has drawn up complete specifications to be used in government departments, copy of which can be readily secured. Whether coal is bought on analysis or not, sample should be frequently taken and analyzed to check up what efficiency is being obtained. For this purpose, an approximate analysis will be sufficient, giving moisture, volatile combustible, fixed carbon and ash. Enough consideration is not given in buying coal to the matter of the ash, as to its fusing point for the successful working of the type of grate or stoker installed. Tests made on the Jones underfeed stoker show that some ash will fuse at a temperature of over 2500 deg. F. and is classed as non-clinkering, and other ash under 2500 deg. F. is classed as clinkering.

Avoid ash that contains silicate less than 30 per cent; alumina less than 30 per cent; iron oxide above 15 per cent; lime above 10 per cent; magnesia above 3 per cent; but it must be borne in mind that coals with a low ash are the most efficient, both from a theoretical point and a practical point of view. More ash means more labor in handling the fires and carrying away the ashes, a greater air pressure is required and there is greater loss through infiltration of cold air through the boiler settings.

Procuring a sample of coal for analysis is as important as the analysis itself, because a non-representative sample will not produce correct deductions. The Bureau of Mines requests that 1000 lb. for a sample be taken in all cases, but for small plants getting coal in by carload or by the wagon load, representative shovelfuls taken from different parts of the car or wagon or pile on the ground to the extent of 350 lb. would suffice. This should then be crushed either through a crusher or with an iron tamper and thoroughly mixed; then divide the sample into four quarters and take one quarter and mix it up again, and further divide into four quarters. Take this last quarter and put it into an air-tight Mason jar and seal up ready for the chemist.

Losses in the Boiler Room

Look out for the small losses, otherwise this will amount to a large item in a year's time. Consider the following:

(1) Examine the brickwork of the boiler setting carefully for cracks which will allow infiltration of air into the combustion chamber and for air spaces around the structural steel supporting the boiler. The cracks and openings can be detected by examination with a candle—if there are any openings the flame will be drawn in. Another way is when green coal has just been put on to shut down the chimney damper for a moment and the smoke will come out of the cracks.

(2) See that all fire, ash and inspector doors close tight.

(3) See that all your steam pipes are properly insulated with 85 per cent magnesia covering or its equivalent.

(4) Examine your boiler feed pumps and auxiliaries to see that they are not wasting or blowing the steam through the piston rings.

(5) Have the boiler blowoff valve pipe outlet exposed to view so you can at once detect any leaks.

(6) Immediately stop leaks at joints in your steam pipe connections.

(7) Have a smooth boiler room floor and see that all the loose coal is swept up, otherwise it gets mixed with the ash and is lost.

Instruments

Every boiler house should be equipped with:

(1) Three draft gages or one draft gage with three connections, to test the pressure in the air chamber under the stokers or grates; over the fire and outlet to the breeching or stack. By this means you can detect air holes in your fire to find out whether you are using too much or too little draft to get the best results.

(2) Recording steam pressure gage.

(3) Water meter.

(4) CO_2 recording machine.

(5) High temperature thermometer to 1000 deg. F.

(6) Coal scales, recording or otherwise.

(7) Feed-water regulators.

With these instruments results can be checked up at any time and poor results can be detected immediately. No plant can be efficient without the human element getting in, and the well-equipped boiler house with instruments as above is a great factor in getting results from the fireman. He learns to have pride in his work and to aim for results with the proper encouragement from the chief engineer. A boiler room well ventilated in summer and warm in winter adds to the efficiency.

Coal Handling

In the modern boiler house coal is handled mechanically direct into the stoker hoppers; but in many

* Abstract of paper read at the Annual Convention of the Smoke Prevention Association.

† Chief engineer, Under-Feed Stoker Co. of America.

boiler plants of the small size this is not always possible, and in such cases it has to be handled by manual labor. When this is the case many boiler houses can be found where the fireman is making two moves when one would do, and where a careful study of the situation, a little ingenuity displayed and a motion study of the fireman made by the man in charge would reduce the actual work of the fireman one-half.

The principal efficiency obtained in any boiler room is naturally the way in which the fires are handled to suit the coal, established as the most commercially economical to use or that which the location compels. With the high cost of labor and insufficient supply, hand firing is becoming obsolete, and rightly so, except single boiler plants under certain conditions. There are two ways of hand firing, the spreading method and the coking method. The writer's experience is that the spreading method gives the better efficiency in the long run; the coking method, however, if carefully carried out, gives the least smoke, but the difficulty is getting the work done properly; for this reason alone, the spreading method is more efficient. The spreading method consists of opening the doors alternately, spreading the fuel from the front to the back wall evenly over the surface of the fire; this means you always have one side of the fire bright and the other is covered with green coal. The coking method consists of placing considerable coal on the front quarter of the grate and on the dead plates, and after it cokes pushing it gradually back and filling up the front again.

The most efficient practice, however, is to install stokers which can be divided into three types: over-feed, under-feed and chain grates. The over-feed and chain grates are practically mechanical application of hand firing. The under-feed works on a different principle, and was invented by Evan William Jones of Portland, Ore.; it was brought out and successfully carried to its present position as the most economical and greatest capacity generating stoker, with its two types, the Jones Standard hand-cleaned and the new Jones Automatic self-cleaning. The principle of the under-feed stoker is that there is always a hot fire on the top and the green coal is fed underneath; the volatile gases are given off and passing through an incandescent bed of fuel are thoroughly consumed, making the boiler absolutely smokeless except when fires are first started or being cleaned.

With the Jones under-feed stoker you get the full benefit of the heat radiated from the surface of the fire as well as the heat carried to the boiler surface by the hot gases of combustion, and the heat radiated from the bottom of the fire is heating the coal up and distilling off the gases.

A closed air chamber is used, and air is forced through the tuyeres into the retort; the steam pressure controls the whole operation, which is automatic. If the steam pressure goes up, the blower slows down, reducing the volume and pressure of air going through the tuyeres, at the same time cutting down the supply of coal to the retort, making an ideal condition. The under-feed stoker is economically successful on widely fluctuating loads, as it automatically will take care of loads varying from no load to 200 per cent within a period of 3 or 4 min., and do it efficiently.

All stokers, however, demand some intelligence to run them; different kinds of coal require different methods of handling, and no fixed rule for firing, air pressure, etc., can be set down for any particular coal. Coals that by an approximate analysis may appear the same may have to be handled quite differently to get the best results caused by the different composition of the ash.

As a general rule the low volatile, high carbon coals of the East require a fairly heavy fire and high blast pressure to cut the coke. The high volatile coals in the Middle West are successfully burned on an under-feed stoker by running a very light fire at a rapid rate with a large volume of air at a low pressure, and burning them newly mined as possible before they dry out.

High CO_2 and absence of CO results in high initial furnace temperature, and high furnace temperature means greater efficiency. Don't run five boilers at a low temperature and low efficiency, when you can do the work on four boilers at high furnace temperature with greater efficiency. With a CO_2 recording machine the man in charge can check up the efficiency as he goes along. If the CO_2 is averaging less than 10 per cent he should investigate the boilers individually—study the draft gages, taking the temperature of escaping gases and examining the fires to see that there are no holes in them.

Every boiler room of a large capacity should have a technically trained engineer in charge with full authority, whose only duty should be in the boiler house to get results. In the smaller boiler house the chief engineer of the plant, who usually is responsible, should realize that the efficiency of his plant depends to a very large extent on the operation of his boiler room.

Having found out by careful tests which is the best way to burn your coal to the best efficiency, see that the firemen carry out your instructions. Keep a record of the results each fireman gets, and where possible pay him a bonus on his individual efforts and not on the results of the whole.

In conclusion, the value of the use of instruments, the buying of coal by analysis, and other items referred to, is very largely lost if careful records are not kept of the daily results and comparisons made weekly and monthly. Forms should be made out on which should be recorded daily the amount of coal used, water evaporated, temperature of feed water, pressure of steam, CO_2 record and draft pressures, analysis of the coal and the amount of ash wheeled out. From the daily reports, weekly and monthly summaries should be entered on forms and turned into the main office.

THE FUEL ADMINISTRATION, in estimating the coal saving from operation of the "daylight-saving" law, says:

"It was shown that in one district the saving of coal was 17½ tons per 1000 population over the period of seven months. These figures were checked against records obtained from other places in widely separated districts having the same relative conditions, and from the mass of facts thus gathered the estimate of 1,250,000 tons of coal saved is determined."

EVERY TIME you buy anything, people work for you. Save labor and materials for the use of the government.

Ventilation of Turbo Alternators with Cool, Purified Air

ADVANTAGES OF CLEANING AND COOLING VENTILATING AIR FOR TURBO ALTERNATORS, EFFICIENCY OBTAINED BY USING AIR CONDITIONING APPARATUS

PROPER ventilation of electric generators is a matter of great importance. All modern units are designed for a certain allowable maximum temperature in the armature and field windings. With a given load, the temperature of a generator will be a fixed amount above the temperature of the ingoing ventilating air; therefore the cooler the air delivered to the generator, the higher will be its efficiency and capacity. (See Fig. 3.)

Another equally important feature is that of the cleanliness of the ventilating air, unless proper equipment is provided to eliminate the dust or soot from the air, an accumulation of dirt is soon deposited within the machine, greatly reducing the cooling effect. Oily vapors that exist in air taken from the inside of power plants make such accumulations in the air passages particularly rapid.

Dirty air means excessive heat, which not only increases the ohmic resistance of the windings, but shortens the life of the insulation, causing grounds, short-circuited winding and even burnouts, unless the generator is taken apart and cleaned often. Therefore the same consideration should be given to the quality as is given to the quantity and temperature of the ventilating air.

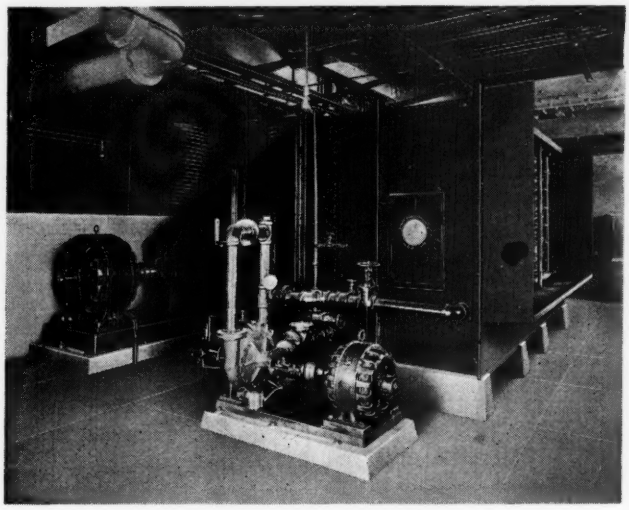


FIG. 1. TYPICAL AIR CONDITIONING APPARATUS INSTALLED IN LONG ISLAND CITY PLANT OF PENNSYLVANIA R. R.

The safe load of a generator is based on a fixed maximum temperature attained by any part of the windings, which must be well below the critical temperature of the insulation. Cooling and purifying the air which is circulated in the machine directly increases the capacity of the machine by allowing a greater temperature rise without exceeding the specified limit of temperature.

Figure 3 is a curve giving the kv.a. load on turbo alternators as a function of the temperature of the entering air, and, since the standard air temperature for electrical machinery is 77 deg. F. (25 deg. C.), 100 per cent load is taken at this temperature.

For example, assume the temperature of the air to be 90 deg. F. (32.2 C.), with a relative humidity of 45 per cent. The curve shows that with air at this temperature the safe capacity of the generator is only 87 per cent of full load rating.

If the air was passed through an air washer and cooler, reducing the temperature to, say, 74 deg. F. (23.3 C.), this would enable the generator to carry 102.5 per cent full load rating, resulting in a gain of approximately 15 per cent, with the power required to operate the washer less than one per cent of the generator rating.

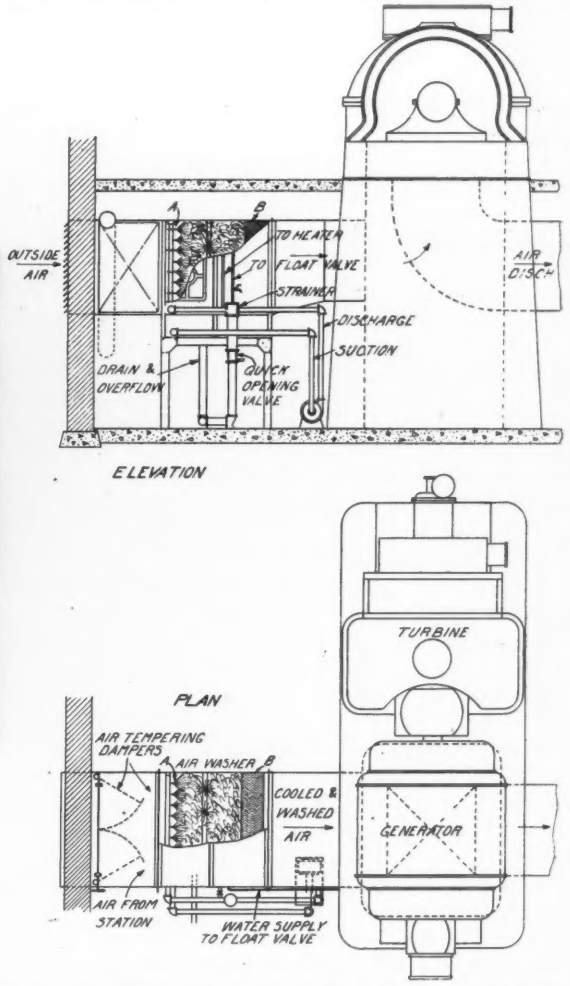


FIG. 2. ARRANGEMENT OF AIR WASHER WITH RESPECT TO GENERATOR

The amount that the air is reduced in temperature depends on its temperature and humidity before it enters the washer, as well as the quantity of water sprayed and the character of the spray.

From the accompanying table, compiled by the General Electric Co., an idea can be secured as to the reduction in temperature of air and the increase of load obtained by use of a humidifier; giving also gallons of water evaporated per thousand cubic feet of air.

With higher initial air temperature or lower humidities the cooling obtained, and consequently the gain in load carrying capacity, will be greater. An increase in load carrying capacity means an increase in its earning capacity.

Few people realize the enormous quantity of air required for ventilating large turbo generators.

Assume a moderately large generator using 65,000 cu. ft. of air per min. This amount of air weighs approximately 2½ tons, so that within one-half to three-quarters of an hour a modern turbo generator handles an amount of air equal in weight to its own total weight.

TABLE SHOWING EFFECTS OF HUMIDIFIER IN VARIOUS LOCALITIES

Reduction in temperature of air and increase of load obtained by the use of a humidifier; also gallons of water evaporated per thousand of cubic feet of air.

Average values for the months of June, July, and August, and the years 1911 and 1912.

	Without Humidifier		With Humidifier			
	Air in Deg. C.	Load in Per Cent of Load When Air is 25 Deg. C.	Air in Deg. C.	Load in Per Cent of Load When Air is 25 Deg. C.	Per Cent Gain in Load	Gallons of Water Evaporated per 1000 Cu.Ft. of Air
San Francisco, Cal.	13.6	114	11.7	116	2	0.0083
Bismark, N. D.	19.1	108	15	112	4	0.0173
Jacksonville, Fla.	26.7	98	23.6	103	5	0.0108
Albany, N. Y.	20.3	106	16.6	111	5	0.0144
Boston, Mass.	21.4	105	17	110	5	0.0182
Chicago, Ill.	23.3	104	17.8	109	5	0.0176
New York, N. Y.	22.8	103	18.2	108	5	0.0186
Indianapolis, Ind.	23.4	102	18.2	108	6	0.0214
San Antonio, Texas.	28.8	94	22	104	10	0.0283
Phoenix, Ariz.	30.8	90	19.2	108	18	0.0468

A comparison of the average conditions in New York City for June, July, and August, 1911 and 1912, with the maximum condition of July 9, 1912.

Average	22.8	103	18.2	108	5	
Maximum	35.6	81	25.6	99	18	

With 65,000 cu ft. of air per min. passing through the machine, a total of 93,600,000 cu. ft. will be handled in 24 hr. As a rough approximation, it may be assumed that one hundred-millionth of the volume of the air in the vicinity of the power plants consist of dust, dirt and other foreign particles. This would mean that 0.936 cu. ft. of dirt would pass through the machine in 24 hr., or 86 cu. ft. in three months. While a part of this dirt will pass directly through the machine, a portion will be deposited, due to the air swirls and eddies, in the air passages.

Such deposits of dirt become a considerable handicap to the ventilation as the quantity of air is decreased, due to the partial closing of the ventilating passages, consequently the cooling effect of the air is greatly diminished, owing to the fact that the air cannot come directly in contact with the heat-radiating surfaces.

Clean and cool air lengthens the life and increases the efficiency of the generator. A large percentage of all short-circuits and burnouts of generators is due to foreign matter breaking down the insulation resistance. A clean generator is comparatively free from such troubles, it is clear therefore that an air conditioning apparatus may prevent a serious accident with a resulting loss many times exceeding the cost of its installation.

Figure 1 shows a 60,000 cu. ft. per min. air conditioning apparatus, manufactured by the Spray Engineering Co., and installed to wash and cool the air for a 21,000-kv.a. Westinghouse turbo generator at the Long Island City, N. Y., plant of the Pennsylvania Railroad. According to the manufacturer, the output of this one machine during the first 12 mo. of service, beginning January, 1915, was about 95,000,000 kw.-hr. That this machine was carrying its share of the load is

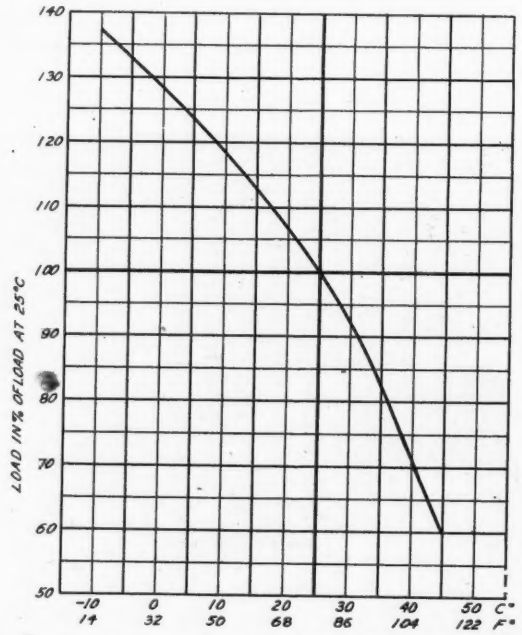


FIG. 3. DIAGRAM SHOWING PERMISSIBLE LOAD OF A TURBO ALTERNATOR AS A FUNCTION OF THE TEMPERATURE OF THE INGOING AIR

evidenced by the fact that 24 hr. times 365 days times 21,000 kv.a. times 80 per cent power factor is 147,000,000 kw.-hr., corresponding to a load factor of 64½ per cent. A direct current voltmeter, connected with a copper strip exploring coil on the windings, showed that not only were the windings cool, but that they were also free of foreign substances after 15 months' service.

It is the opinion of the Westinghouse Electric & Mfg. Co. that air conditioning apparatus can be used to distinct advantage for turbo-generators of any capacity, and that it is particularly desirable for those of 500 kw. capacity and higher. The materials in turbo-generators, on account of the high speed maintained, are worked hard, and any appreciable amount of dust or dirt accumulating in the air passages tends to run up the temperature immediately. While this causes a decrease in efficiency the amount of the decrease is small.

The danger of burning out the machine, however, is great. As the air conditioning apparatus serves to keep dirt and dust from accumulating this danger is minimized and there is little likelihood of any hazardous increase in temperature.

As a rule, air conditioning apparatus is not used to any extent in connection with air-blast transformers. The only places where air-blast transformers are used are in large plants. Most of these plants are operated as substations, and as the transformers are mostly used as part of the substation apparatus, it would be here that air conditioning apparatus would be utilized. As, however, it hardly ever pays to go to the expense of installing such apparatus, it is little used. Of course, without air conditioning apparatus the transformers need regular inspection, but inspection is a good thing and should be insisted upon. Provided the inspection is good, air conditioning apparatus is not necessary to the successful operation of air-blast transformers.

In recent years an apparatus, called a humidifier, has been used to clean and cool the air supplied to

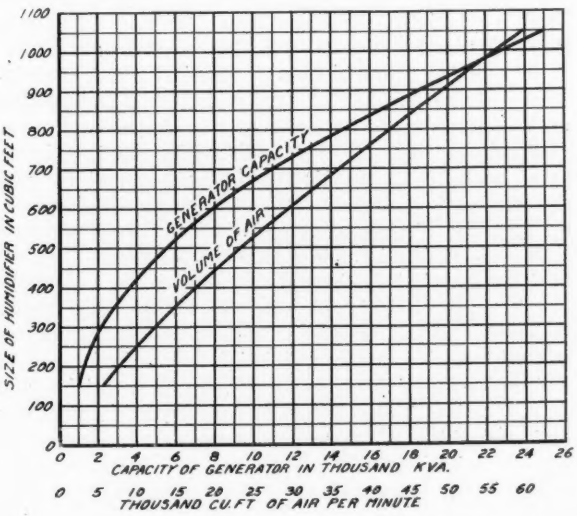


FIG. 4. APPROXIMATE SIZES OF HUMIDIFIER FOR VARIOUS CAPACITIES OF GENERATORS AND QUANTITIES OF AIR REQUIRED

turbo-alternators, as illustrated in Fig. 2. A centrifugal pump delivers water to spray nozzles A at about 30 lb. per sq. in. pressure. The water emerges in a fine spray and is thoroughly mixed with the air, which enters at the left. Any particles of dirt are saturated with water, which increases their weight. The air, dirt and spray enter at the eliminator B. This consists of vertical sheet metal plates, which form zigzag passages for the air. The particles of wet dirt and water, having greater inertia than the air, strike these plates and are carried into the settling tank.

After leaving the eliminator the air is clean and free from spray and may be carried directly to the generator. The volume of water in the settling tank is comparatively large to allow the dirt to settle in the bottom before being again taken into the pump. As a further precaution, a filtering screen is placed between the tank and the pump. The water is circulated in the system, hence the quantity added is that lost by evaporation. In a properly designed humidifier the pressure necessary to pass the air through will not exceed 0.5 in. of water. This has practically no effect on the volume of air for the usual steam turbine installation. The results of two tests on machines in commercial service, with the load remaining the same under both conditions, are:

	Dirty	Clean
Machine No. 1 rise at armature windings	54	37
Machine No. 2 rise of armature core	54	41

In Fig. 3 is given the kv.a. load on turbo alternators as a function of the temperature of the entering air. This curve was derived from representative 25 and 60 cycles machines. The load is based on a fixed maximum temperature attained by any part of the windings. Since 25 deg. C. is a standard air temperature for electrical machinery, the load at this temperature is taken as 100 per cent load.

If the air is taken from out of doors in a temperate climate, its temperature may vary from 0 deg. C. in winter to 40 deg. C. in summer. Reference to the curve shows that the ratio of loads at these two temperatures is 127:70.

The question naturally arises as to the possibility of economically cooling the air when its temperature is too high. This is done by the humidifier, whose operation has been described in connection with the washing of the air. In passing through the spray chamber, the air becomes saturated with water vapor by the process of evaporation, thereby lowering the temperature of both the air and water. The amount that the air is reduced in temperature depends on its humidity before it enters the humidifier. If the air is saturated before entering, it is obvious that there would be no evaporation and no reduction in temperature.

As an example, consider the following conditions: Entering air at 96 deg. F. Relative humidity 0.39. Under these conditions the air will leave the humidifier with 100 per cent humidity, meaning saturated with water vapor, and theoretically the temperature of the air leaving the humidifier should be 76 deg. F.

Actually it will be slightly higher, but 2 deg. F. is ample allowance. The air is therefore at a temperature of 78 deg. F. Since the water is circulated in the system, it also maintains a temperature of 78 deg. F. Reference to the lower part of the table shows that the relation of the loads under the two conditions is with humidifier 0.99, without humidifier 0.81.

This air leaves the humidifier at the same temperature as the water. If there is an abundant supply of water at a temperature considerably below that which may be obtained by evaporation, it may be better to make continuous use of this supply instead of circulating the water in the humidifier, especially when conditions tend to high generator temperatures. The benefit obtained in different localities may be greater or less. The table also gives the average temperature of the air and the per cent load which may be carried with and without the use of a humidifier, data from a number of cities in different parts of the United States, taken during the months of June, July and August and the years 1911 and 1912.

This table represents average conditions. There are times when the gain is much larger.

Having gone into the subject of cleaning and cooling the air supply for turbo-alternators, the question naturally arises as to when it will pay to install air conditioning apparatus.

There are various ways of figuring whether an investment in air washers is actually justified. Consider a typical modern steam turbine power station containing three 10,000-kw. turbo-generator units. During the four summer months the permissible load on the generators would be reduced from full load rating about 5 per cent on the average, on account of the warm atmospheric conditions. In most stations it is necessary to operate at rated full load during this period.

In order to generate the full 30,000 kw. during the hot months it would, therefore, be necessary to do one of three things, install air washers, increase the size of the electrical end of the units or install a spare unit. For illustration, it is sufficient to compare the first two.

Each of the 10,000-kw. machines would require a washer of 40,000 cu. ft. per minute capacity, and the total cost of the three washers would be in normal times about $7500.

The fixed charges on this investment, including interest, taxes, insurance, maintenance and depreciation taken at 15 per cent, are $1125 per annum.

Adding to this $250, the operating cost of three 7½-hp. pump motors run one-third of the time, gives a total expense of $1375 per year for the air washer installation.

On the other hand, if it be assumed that the size of the electrical end equipment is increased 5 per cent (which is, of course, low), so that full load may be carried at all times, the extra cost would be about $30,000, figured at $20 per kw. The fixed charges on this at 15 per cent are $4500. The cost of dismantling and cleaning per unit of this size once a year is approximately $500; adding this to the cost as described would be $6500.

The net saving by installing air washers would therefore be $4625 per annum for this 30,000-kw. station, or at the rate of about 15½ cents per kw. per annum. In other words, even on this conservative basis, the washers would pay for themselves in a little more than a year and a half, without taking into account the benefits accruing from washed air, such as the insurance against accident and the losses incurred when the machines are out of commission for repairs and cleaning.

IT IS ESTIMATED by experts from the Bureau of Mines that fuel sufficient to operate the railroads of the U. S. for a month is being wasted each year by users of fuel oil. Last year 160,000,000 bbl. were used, of which one-fourth, or 40,000,000 bbl., might have been saved by more intelligent operation of plants and proper firing.

In this situation, the Bureau of Mines, and the Fuel Administration have sent to those parts of the country where fuel oil is used extensively, engineers to visit the plants and demonstrate how losses occur and may be stopped. A handbook for boiler plant and locomotive engineers has been prepared and Van H. Manning, Director of the Bureau of Mines, has ordered a copy sent to each plant known to be using fuel oil. A copy may be secured by writing to the Burea uof Mines, Washington.

Stoker Manufacturers' Association

AT A MEETING in Cleveland on Aug. 1, 1918, an association was formed of the stoker manufacturers of the United States. The principal reason for getting together was to place at the disposal of the Government the entire facilities of the stoker industry to the end that everything possible might be done to help out in the national emergency. Even after the war, however, it is expected that great benefit will be obtained by the Association members in the discussion of subjects of interest and value to the stoker industry; in the advancement and improvement of that industry; in the standardization of stoker manufacture and application, and in the promotion of a spirit of co-operation among its members for improved production and increased application of stokers. Practically all of the builders of mechanical stokers are included as charter members of the Association.

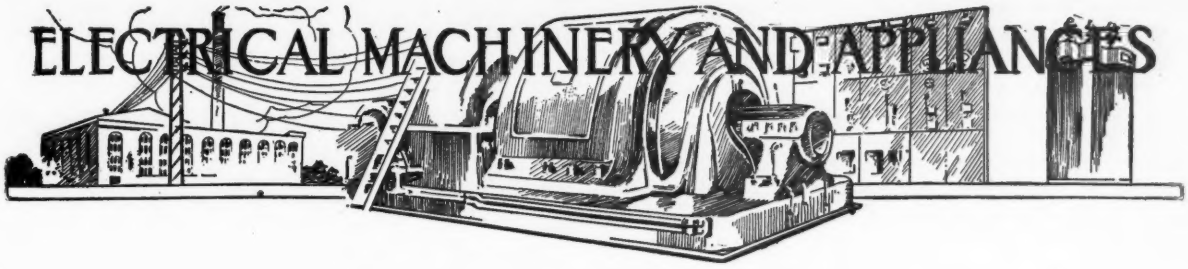
At the first meeting, the following officers and executive committee were elected: President, P. Albert Poppenhusen, Chicago, Ill.; Vice-President, S. L. Nicholson, East Pittsburgh, Pa.; Secretary-Treasurer, Fred H. Daniels, Worcester, Mass.; William F. Sauter, Philadelphia, Pa.; W. H. Rea, Detroit, Mich.

The Stoker Manufacturers' Association has been informed that it has been formally elected to membership in the Chamber of Commerce of the United States. A national councillor will be appointed by the Association to represent it in the National Chamber, and through this national councillor the Association will have an opportunity of expressing itself on national questions under discussion by the Federal authorities.

The Association, through its War Service Committee, has tendered the Federal Government the entire resources and services of its members, and the committee is working with the Fuel Administration and the War Industries Board for the conservation of fuel, labor and raw materials. The Association is prepared to do any and everything which may be necessary to prove that American business is ready to back up the Government until victory is assured.

CHAIRMAN HURLEY, of the U. S. Shipping Board, urges that steps be taken at once to increase our consular service abroad and to reform our regulations for clearing ships flying the American flag. Uncle Sam expects to have 25,000,000 tons of merchant shipping within 2 yr., and when this is released, after the war, for commercial service it will be scattered over world trade routes, increasing the work required of consular offices beyond the power of present organizations to handle.

Fully 50 men are needed right now, and if Congress would authorize the extension of service, they would be found and sent abroad at once. Such men will be called upon by manufacturers for a great mass of information about trade in other countries. They should have a broad education, business experience, tact in dealing with people, an acquaintance with one or more foreign languages and technical knowledge of consular duties. This means that the salaries to be paid must be larger than in the past if men fitted for the work are to be secured. And it is none too early to begin now by action of Congress and training of men to prepare for the serving of our great fleet when peace comes.



Vertical Generators for Water-Wheel Drive

FEATURES AFFECTING LIFE OF MACHINE

PRESENT DAY fuel and labor shortages, with their consequent increased costs, are going to be instrumental in the promotion of many new hydro-electric developments.

Of our 55,000,000 hp. of unused water resources, a great many thousands can be developed economically to meet the existing requirements for electrical power, and these will be a material factor in the conservation of our fuel, and towards the elimination of railroad congestion and car shortage. Legislation, favorable to such development, is to be expected of our state and national lawmakers.

wheels and generators must both be designed to meet the conditions imposed by nature. These conditions vary widely, and the range in capacity and speed encountered demands an equally broad experience.

Single runner vertical wheels, of exceptionally high efficiency, are now available for at least all of the low and medium head developments, and it is to be expected that the majority of our future installations will be of this type. The success of the vertical type depends on the satisfactory operation of the thrust-bearing, carrying the weight of the revolving parts.

Proposed governmental legislation seems to have determined 50 yr. as a reasonable period for water-right leases. Whether electrical apparatus will last this long remains to be seen, the art still being considerably less than 50 yr. old, and obsolescence so far being responsible for far more scrapping of material than wear and tear. Certain it is, however, that today no manufacturer is justified in counting on obsolescence for protection, and only those materials which will wear the longest should be employed in the building of water-wheel generators.

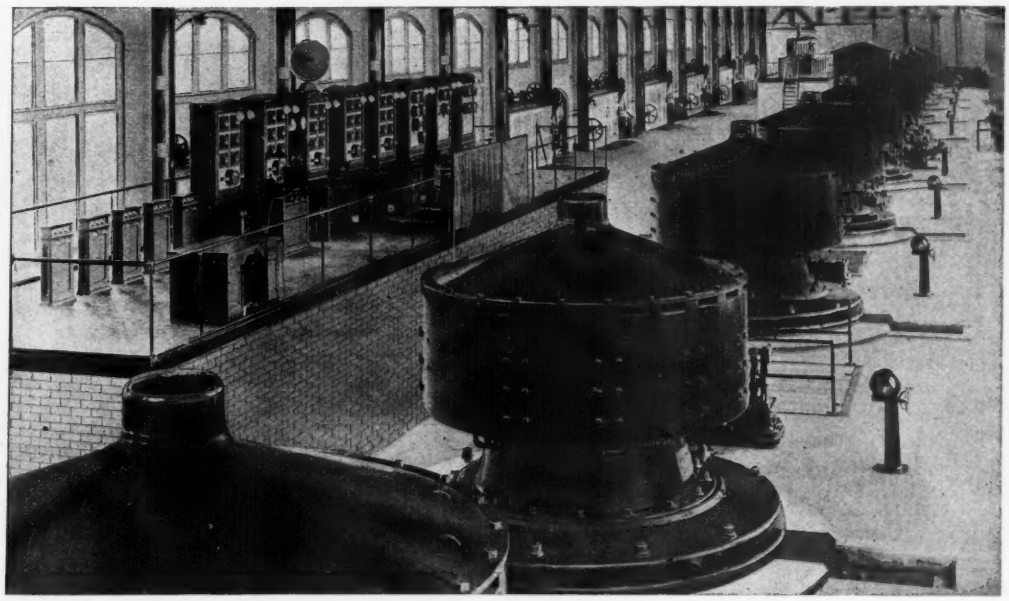


FIG. 1. THE FIRST "HYDRO" PLANT IN AMERICA—STARTED IN 1895 AND STILL GOING—NIAGARA FALLS, N. Y.

In 1895 the Westinghouse Electric & Mfg. Co. built the generators for the first large station in America and it has manufactured many hundreds of machines at its plant in East Pittsburgh, Pa., since that date. Today these units are furnishing, economically and reliably, light for our homes, our factories, and our cities, power for our mills, our mines, and our networks of railroad and railway lines.

We, of America, expect high efficiency from our people, and from the machines which they manufacture. To utilize our waterpowers to the best advantage, water

One of the most frequent causes of generator shut-

downs has been, and probably will be, failure of the armature insulation. By a happy choice, engineers early decided on mica, a material which does not age, which is unaffected by temperatures far higher than those found in the modern well-ventilated generator, and which remains unimpaired under the static discharges common to all high voltage machines. Efforts have been directed for many years to the perfection of methods in the application of this material as armature coil insulation.

The danger of runaway speeds, 50 to 100 per cent above normal, is ever present in the hydro-electric plant, and a rotor construction which safely withstands the stresses incident to this abnormal condition is essential. No single type of construction will cover, with safety and economy, all the range of capacity and speed encountered. Cast iron is satisfactory only for low peripheral speed rotors, steel castings, if of very large size, may not be sufficiently uniform in strength to rely on. Laminated steel rims and rolled steel plates are sometimes resorted to for high-speed service. Successful

FIG. 2. FOR COTTON MILLS AND GENERAL POWER PURPOSES FIVE 2700-KV.A., 2300-VOLT UNITS—AUGUSTA, GA.

types of construction to fit each and every case have been designed and thoroughly tried out.

With a completed product made up of so many small but essential parts, careful inspection and test is desirable. Each operation during the process of manufacture is carefully inspected, all materials employed are well tested and whenever feasible the finished machine is given a running test under conditions approximating those of normal operation.

BACK UP those who are offering their all—buy War Savings Stamps.

Changing Speed of Induction Motors

POSSIBLE SPEED CHANGES OF INDUCTION MOTORS TO SUIT CONDITIONS IN POWER PLANTS AND HOW TO GO ABOUT IT

FREQUENTLY engineers find it necessary where motors are used to drive pumps, compressors and machinery about a power plant to change motors from one machine to another; especially in emergency cases.

Often they find themselves confronted with the problem of speed. A certain piece of machinery must be driven at a rated speed while another may be of a different speed, and it is often the case that when a

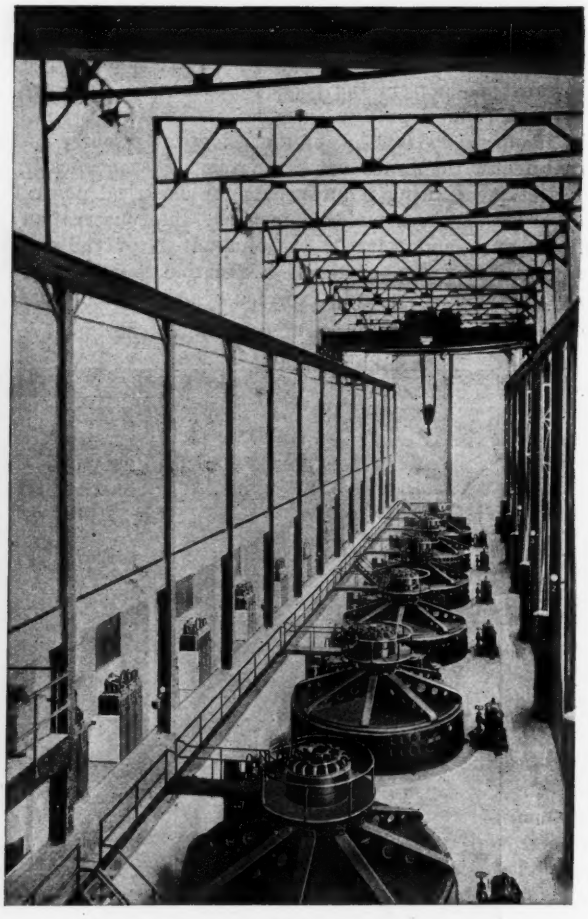


FIG. 3. SIX 14,700-KV.A., 6600-VOLT GENERATORS SERVING THE "ELECTRO-CHEMICAL CENTER OF CANADA," QUEBEC, CAN.

motor is to be used to drive another piece of machinery that its speed is either too high or too low for direct connection to the machinery to be driven.

The proper speed must be obtained by either pulleys or counter shafting or by buying a motor with the proper speed, which is not an easy matter nowadays, as a motor sometimes is a hard machine to find; and again the chances are that a motor with the required speed cannot be gotten within any reasonable length of time.

All of these cases require considerable loss of time, money and probably damage to machinery.

Again we find another case where a motor may burn out and must be sent to the repair shop, or a winder sent for to rewind the motor, which takes time; and the revenue derived from the driven machinery is lost during the time required to repair or rewind the motor.

Quite frequently a spare motor can be gotten from some neighboring plant or there may be one in stock, but the problem of speed is again a blockade because this spare motor may run too fast or too slow for the purpose.

In the case of a direct-current motor, and the difference in speed desired and the motor speed is not too great, the problem can be solved by the use of resistance or a water barrel. In the case of an induction motor, however, there is no such thing as using resistance unless the motor is of the variable speed type which is not often found in motors driving machinery built for constant speed. The engineer is confronted with the problem of how can I get the right or nearly the right speed out of this motor that I can get from my neighbor, or that I have in stock, without going to the expense of installing counter-shafts or buying pulleys.

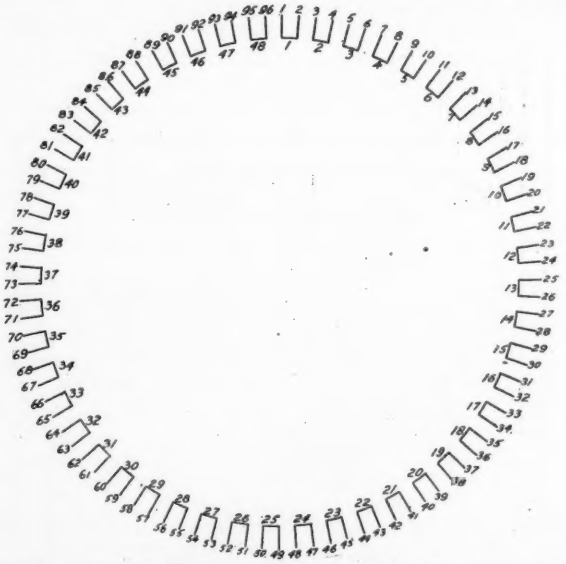


FIG. 1. SHOWING 48 COILS IN STATOR WINDING—EACH COIL HAS 2 LEADS NUMBERED FOR FORMING CONNECTIONS FOR DIFFERENT NUMBERS OF POLES

This problem can be solved in many cases by changing the connections of the motors. We find the speed of an induction motor based on the number of poles and the frequency. Thus the speed in revolutions per minute is equal to 120 times the frequency in cycles per second divided by the number of poles. Hence, if we have a 2-pole motor designed for 60 cycles the speed of this motor will be $\frac{120\times60}{2}$ = 3600 r.p.m., eliminating of course all losses. Now, in order to get a speed of 1800 r.p.m. we must have a 4-pole motor (frequency remaining 60 cycles). If we want a motor to run at 1200 r.p.m. we must have a 6-pole motor.

The question will naturally arise in the mind of the engineer, how can this be done, what must I change in the winding of the motor to change its speed, how can I change the number of poles in the motor? By following these instructions and carefully consulting the table shown, this can be accomplished with little difficulty.

We will take a standard motor having 48 slots and 48 coils in the stator winding. A three-phase motor 60 cycles will be considered in this article. If the motor runs at 3600 r.p.m. it must be a two-pole motor. Being a two-pole, three-phase motor, having 48 coils, there must be eight coils per pole per phase. To find the number of coils per pole per phase use the following rule:

First find the number of poles; $\frac{2\times60\times\text{frequency}}{\text{speed}}$ = poles. The next step is to count the number of coils in the motor. (We are considering 48 coils.) Multiply the number of poles by the number of phases and divide the number of coils by this product:

$$\frac{48}{2\times3} = 8 \text{ coils per pole per phase}$$

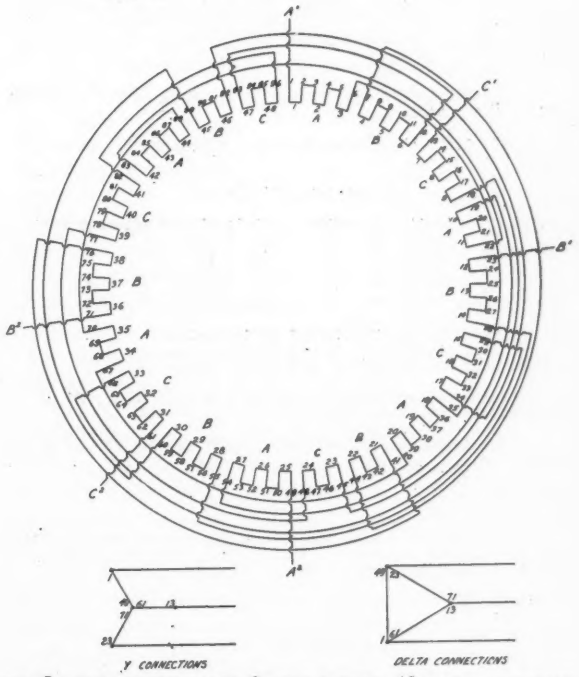


FIG. 2. CONNECTIONS FOR 6-POLE MOTOR, 48 COILS, SHOWING HOW COILS ARE DISTRIBUTED TO BALANCE MOTOR WINDING

We find that the motor has eight coils per pole per phase at 3600 r.p.m. We need a motor that will run at 1800 r.p.m. Next step is to find the number of poles this motor must have to run at 1800 r. p. m., using the formula we find; $\frac{120\times60}{1800}$ = 4. This motor must have 4 poles for this speed. To find how many coils per pole per phase $\frac{48}{4\times3}$ = 4, hence 4 coils per pole per phase. By regrouping the coil in the motor as shown above we get a motor to run at 1800 r.p.m. or the speed desired. This, however, does not stop at this point. As-

sume the speed desired is 1200 r.p.m. $\frac{120\times60}{1200} = 6$, the motor must be a 6-pole motor, and how can we find the proper way to distribute the winding to get a balanced

TABLE SHOWING POSSIBLE SPEED CHANGES OF 3-PHASE 60-QYCLE INDUCTION MOTOR HAVING 48 COILS AND NECESSARY CONNECTIONS

Possible speed changes of a 3 phase induction motor having 48 coils, 2 poles, 3600 R. p. m. at 60 cycles.

Total No. of Coils	Frequency	No. of Poles	Speed per min.	Coils per pole per phase
48	60 cycles	2	3600	8
"	" "	4	1800	4
"	" "	5	1200	Mixed groups
"	" "	8	900	2
"	" "	10	720	Mixed
"	" "	12	600	"
"	" "	16	450	1

2 poles 3600 r.p.m.

2 to 15 inclusive in series
18 " 31 " " "
34 " 47 " " "
50 " 63 " " "
66 " 79 " " "

82 to 95 inclusive in series
16 and 64 in series
48 " 96 " "
80 " 32 " "

For Y connection 1, 33 and 65 are line leads, 9, 49 and 81 form the star.

For delta connection 1 and 8, 17 and 33, 49 and 65 are the line leads.

4 poles 1800 r.p.m.

2 to 7 inclusive in series
10 " 15 " " "
18 " 23 " " "
26 " 31 " " "
34 " 39 " " "
42 " 47 " " "

50 to 55 inclusive in series
58 " 63 " " "
66 " 71 " " "
74 " 79 " " "
82 " 87 " " "
90 " 95 " " "

8, 49, 56, 32, 25 and 80 in series
24, 65, 72, 48, 41 and 96 in series
40, 81, 88, 16, 9 and 64 in series

For Y connection 1, 17 and 33 are line leads, 57, 73 and 89 for the star.

For delta connection 1 and 57, 17 and 73, 33 and 89 are line leads.

8 poles 900 r.p.m. the groups are reduced in proportion to the figures shown for 2 and 4 poles, which also applies to a 16 pole 450 r.p.m. motor.

6 poles 1200 r.p.m.

2, 3, 4, 5 in series
8, 9, 10, 11 " "
14, 15, 16, 17 " "
20, 21, " "
24, 25, 26, 27 " "
30, 31, 32, 33 " "
36, 37, 38, 39 " "
42, 43, " "
46, 47, " "

50, 51, 52, 53 in series
56, 57, 58, 59 " "
62, 63, 64, 65 " "
68, 69, " "
72, 73, 74, 75 " "
78, 79, 80 81 " "
84, 85, 80 87 " "
90, 91, " "
94, 95, " "

6, 35, 40, 67, 70, 88, 83, 22, 19, 54 in series. Phase A.

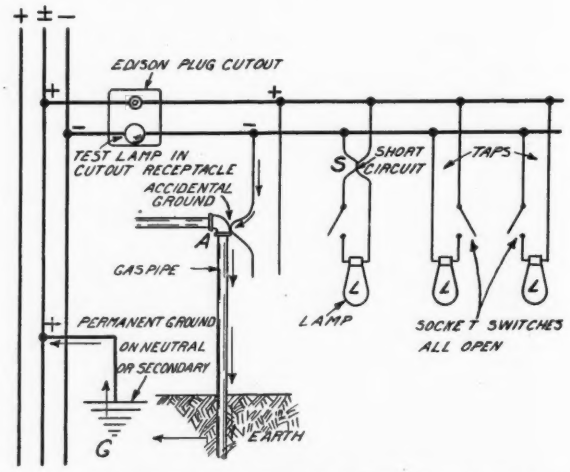
18, 45, 48, 77, 82, 96, 93, 34, 29, 66 in series. Phase C.

28, 55, 60, 89, 92, 12, 7, 44, 41, 76 in series. Phase B.

For Y connections 1, 13, 23, are line leads; 49, 61, 71, form the star.

For delta connections 49 and 23, 71 and 13, 61 and 1 are line leads.

motor. By using the formula coils divided by (poles times phases) we find that we have a few coils left over, which must be connected in order to retain efficiency and not cause the motor to heat by cutting out part of its windings. This is done by what is called mixed grouping the winding, meaning that some poles will have more coils than others; but they must be distributed so as to have a balanced winding. The way to solve that is by dividing 48 by 6×3 which gives us 2 in even numbers and leaves 12 over. Now we must distribute these 12 coils in equal proportion. We have three phases $\frac{12}{3} = 4$. We find that each phase must be given four coils more, and adding these four coils to the number of coils already in each phase we find that there will be $2\times6+4$ or 16 coils per phase. These 16 coils must be divided into 6 poles, by adding 1 coil to 4 of the poles which gives us 4 poles with 3 coils per pole per phase and 2 poles with 2 coils per pole per phase, and by equally distributing these 2 coils so that the magnetic field of the stator winding will be of the same strength on both sides of the poles having 2 coils a balanced winding will be found. Figure 2 shows the distribution of the coils in a mixed group winding having 6 poles, 48 coils.



METHOD OF TESTING FOR TROUBLE WITH INCANDESCENT LAMP IN CUT-OUT SOCKET

By checking up the diagram, Fig. 1, with the numbers as shown, any possible number of poles and speed can be secured by changing the connection as explained in this article and thereby saving your plant a considerable outlay of money, time and worry. The distribution of coils in a motor having 72 coils will be discussed in a future issue.

Locating Trouble with Lamp in a Fuse Block

BY J. C. COLONNA

THE method of locating faults on incandescent lamp circuits by means of a test lamp placed in the cut-out or fuse block of the Edison plug type is shown in the accompanying illustration. Where tests are being made in this way an incandescent lamp, *L*, is screwed into the receptacle (on the ungrounded side of the circuit) in an Edison plug cut-out, through which the circuit is fed. This lamp serves as an indicator and also as a resistor to limit the current through the cir-

cuit. In case of a short-circuit, as at *S*, the lamp will light, or with a ground, as at *A*, the lamp will light also. Trouble can be localized by first putting the lamp in the service-entrance cut-out receptacle and with all of the branch circuits connected. In the case of a ground or short-circuit, as suggested in the sketch, the lamp will light. Then both sides of the branch circuits are successively opened until the lamp goes out. This localizes the trouble to a single branch circuit. Now the trouble can be further localized by putting the indicating lamp in the cut-out serving the branch circuit, making test as above suggested.

In making trouble locations by this method, all of the incandescent lamps or the receiving devices on the circuit must be opened by the socket or individual switches through which they are fed. The whole process of finding the trouble is one of elimination. With the test lamp in position in the cut-out, disconnect circuits or part of circuits until that circuit or the part of the circuit in which the difficulty exists is identified.

Interesting the Factory in the Power House

CHIEF ENGINEER APPEALS TO SPORTING INSTINCT OF MEN TO BRING ABOUT REDUCTION IN COAL CONSUMPTION. BY L. W. SCHMIDT.

THE CHIEF sat at his desk making a sour face. John, his assistant, was standing next to him trying to imitate the example of his friend and superior.

"The old man is down on us again because we use too much coal," said the Chief. "I have gone over the figures again and again, and there is something in it. We use a good deal of power in this factory, but I cannot make out why. I have gone after the firemen and have given them a bit of my opinion, but they cer-

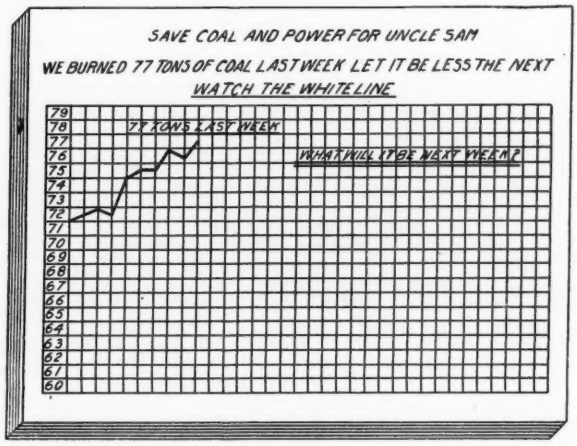


FIG. 1. COAL CONSUMPTION CHART AS IT ORIGINALLY APPEARED

tainly are mighty careful now. And you and I are worrying our heads off what we can do to keep the bill down. But there is the old man. 'Chief,' he says, 'you are using too much coal. What I want to see are results. You will have to show them or something will happen.' "

John stood and thought for a while.

"Chief," he said finally, "it's not with us here where the trouble lies. We have dandy equipment and it's nearly new. Our men are careful and everything is up to top notch. It's the crowd in the factory that is at fault. It's they that won't see the best power engine can't give more than it is built for. I remember when I was still in the electrical business there was a firm that had just installed those new dictaphone machines. They had quite a number of them and were almighty proud of them. So they had them running for fun all the day, and when you looked into the place it looked like a sewing machine shop, all the wheels turning. One afternoon they overdid it and the fuse blew out. That set them thinking. Their electric bill helped a bit to their further education and they saw that running those little things without having anything to say to them was a costly business. So a notice was posted in the place, 'Do not let your motors run while the dictaphone is out of use,' or something similar. It had a powerful effect on their electric light bill, and everybody was happy ever after. That's what they do in this outfit. They let the machines run empty, they would let them run during lunch hour just for fun if we would not shut off from here. If the old man wants to save coal, we have to go after the people in the machine shop; that's what's the matter with us."

The Chief had a long walk over it on Sunday, and when he came to the factory on Monday morning he went to the Boss.

"Boss," he said, "if you want us to save coal in the power house your people in the workshops will have to help us. It's at their end where the trouble is. Likely that we can do a little more on our side if we cut down the pressure on the boilers and give them more rest during the day."

The Boss saw the point. He said: "Chief, I believe your are right, but what can we do? The foremen are running all over the place urging the men to be more careful with the machines, and we have posted notices all over. But it is going on; in fact, it is getting worse with all the new men coming in and the old going to the front. And the coal bill is something fearful to look at."

"The foremen are all right enough, but they forget sometimes themselves what's necessary. You can't always drive a man to do a thing; he will get sick of it and go somewhere else. If there is a salvation it must come from the men themselves. I have been one of them, and I may be one of them again, and I know how they feel about it. They are all willing enough, but they do not see the point. And they won't see the point until we show it to them."

"That all seems right to me, but how do you propose to show it to them?" asked the Boss.

"I have to go for them myself. I must get them into line with me. They must see what our troubles are in the power house and how they can help us to solve

them. After all, it's their job that will go if mine goes."

So it was agreed that the Chief should take the men in hand.

John had the time of his life. The Chief was busy in the carpenter shop making three large wooden boards. One evening he stayed behind an hour and neatly painted the boards black. The next day he had a long conversation with the head draftsman of the factory, and there were more evening consultations. The result came out a few days later.

Three blackboards appeared in the factory. One hung in the entrance hall where the men entered the factory, one in the power house and one in the principal workshop. Each had the following inscription:

To Our Fellow Employes

Uncle Sam wants this shop to save coal. We have done in the power house all we can do. We appeal now to you to help us. Wasted power means wasted coal. Do not waste power; shut off power when not required. Do not let your machines run empty. Every bit of power saved by you will help to keep somebody else warm. Look out for power leaks.

THE POWER HOUSE.

In the power house this notice was supplemented by another one explaining to the men in the power house that this notice was displayed in the workshops and that now their assistance would be required to make the scheme of saving a success.

"It's all right, Chief, what you tell them," said the Boss on Tuesday morning, "but will they do it?" The foremen were openly critical.

"Wait and see," said the Chief, "I have not done with them yet."

The next afternoon he called on the Boss and had a long conversation with him. When he left, the Boss was all smiles. He said, "All right, Chief, I shall foot the bill. I don't mind so much the expense of it; it is the coal I am worrying about. It is our duty to save what we can."

There were more consultations with the head draftsman, and on Saturday morning the blackboards were removed. John was not a favorite with the Chief that morning. The scheme apparently had not been a success. The foremen had known it beforehand and would say no more. Only the men themselves were puzzled. The thing had come very suddenly; it had taken hold of them, and they wanted to see what was on the bottom of it. Also, the matter had been discussed a great deal.

"John," said the Chief in the afternoon, "I have figured it all out. We have used 2250 tons of coal during the last year and we kept our unit going pretty well. We have more men today in the shop and there are more benches going. So we need more power, and, naturally, more coal, but we should use less than we do now. Last month we used 310 tons and the month before 290 tons. Of course, there are variations in the coal, but we can overcome that. What do you think we should use?"

"Two hundred ninety-five tons," guessed John.

"That's about right, and I tell you, John, I think we could do a few better. If we are very careful we might bring it down to 280 tons a month, 65 tons a week. That's what I am going to tell the men."

The afternoon was spent in cleaning the blackboards and three of the firm's draftsmen set to work with the Chief. The first was to paint white lines on the black background of the boards like those used for statistical charts. These dry, the proper work of inscribing the boards was started. At the head of each board there was the following inscription:

Save coal and power for Uncle Sam.
We burned 77 tons of coal last week. Let it be less the next. Watch the white line.
The Power House.

Underneath there was a chart showing the coal consumption during the last two months, week by week, and blank space for the next six months. Also there was the inscription,

What will it be next week?

The chart as it looked on the first day is shown in Fig. 1.

The chart created some interest when it appeared in the workshop next Monday morning. Here was something to look at. Workingmen as a rule do not take much interest in figures, but this was something different; it was, generally speaking, quite amusing. So the matter of the coal consumption of the power plant found some more publicity. It was discussed during the lunch hour and on the way home. Next morning the foremen noticed a greater care in the handling of the machines and in the power house pressure was not as heavy as usual.

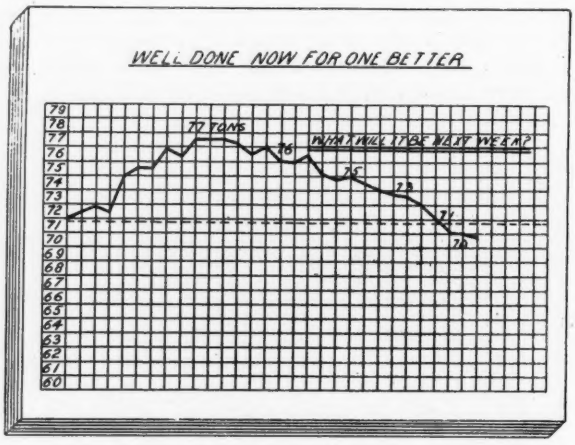


FIG. 2. COAL CONSUMPTION CHART 15 WEEKS LATER

"Of course," said the Chief, "we won't see any results for some while." In fact, towards the end of the week interest began to weaken a good deal, and it had practically vanished on Saturday.

"There your are," said John.

"You are nowhere, Mr. Grimes," responded the Chief. "They are bound to weaken. It has not yet become a habit with them. Watch them next week."

On Monday the Chief had the chart up to date and the inscription changed. It now read:

First week of coal conservation campaign brings only small success. It can be done. Try better this week.

Again there was a showing of interest in the beginning of the week, but a falling off towards the end.

"The duffers are forgetting at the end of the week

what we have told them on Monday," remarked John, who was now beginning to take a proprietary interest in the proceedings.

"We shall have to use stronger language next Monday," was the answer of the Chief; and so he did.

It is going well in the first half of the week, but we lose in the second half. Somebody gets lazy. Look out for him. Thanks for the effort.

On the same day a conference took place in the Boss' office between the Chief and the foremen. The latter were told to look out for negligence on the part of the men, but not to pull them up for it. A report was to be made on them at the end of the week. Much useful information was collected during that week.

"Now we've got them," said the Chief.

This week he ran at the top of the blackboard a single line only:

There will be an important announcement next week. Get ready for it.

This was the fourth week of the campaign, and so far not much had been gained. No doubt there was a reduction of the permanent leaks, and the men had become more attentive; but still careless habits were prevalent and no real savings were made. True, the coal consumption had remained fairly even during the month against the steady increase of the former weeks. Monday came the big announcement.

"Join the power saving brigade," ran the big inscription on the chart. *"Get your membership card today."*

Also there was an announcement on a special poster explaining that the brigade had been formed on the instigation of the power house Chief and that the Boss had become president of it. It was the purpose of the brigade to reduce the waste of power and coal in the factory. Every employe was invited to become a member. Further, it was said that the saving of coal, if it could be effected, would not benefit the Boss only, but that the members of the brigade would share in the savings. The profits would be distributed amongst the members according to the duration of their membership. The first distribution would take place at the end of the first six months. Further distribution to be made in shorter intervals. The rules of the game were simple. Every member of the brigade received a pledge card where a promise was made to assist the power saving campaign of the power house. Members would see to their fellow-employes not wasting power. Members also could be suspended for negligence, but this suspension should not be for longer than one week, during which week the member could not share in the profits.

The Chief had been very busy outlining the scheme during the preceding week and had membership cards printed. Uncle Sam was shown in one corner of the card raising his hat gratefully to the members. Underneath was the pledge "I pledge myself to" and a list of things the member promised not to do. On the back of the card there was a calendar of all the weeks during which the brigade was to work. If the member was suspended, the week of suspension was to be deleted from the card. Also there was a reproduction of the chart as standing on the day when the brigade was formed, and instructions were given how each member could fill it out from week to week so as to see for himself how he stood with the savings campaign.

During the evening the Chief had a table at the factory exit and was busy enrolling members. By the end of the week, all the factory hands had been enrolled. Also, the chart on the blackboard had undergone a change. It now showed a dotted straight line across the six months. If the coal consumption would fall below that line, the profit sharing would begin.

As it appeared 15 weeks later is shown in Fig. 2.

The power house staff, of course, participated in the general distribution as being principally responsible for the way, were to get a special coal bonus outside the general distribution as being principally responsible for any savings.

Now the real work started. The chart was made the central point of the campaign. Every week new inscriptions appeared on the board. When the men had done well, the Chief was appreciative; if they began to slack, he pulled them up. Finally success came. The line sank below the stipulated average and remained there to the end of the first six months' campaign.

When the time came round for the first distribution of the bonus, the amount distributed was not very large. In the meantime, however, the saving power had become a habit with the men, and during the following three months the average weekly savings below the stipulated average of 71 tons ran to 9 tons. Coal then was $8 a ton at an average. The total distributable premium for the next three months, therefore, amounted to 13 times $72, or $936. Forty-one men were employed in the factory and $22.82 was the share of each.

The Chief had been right in his judgment of the men.

The scheme is one which can be applied easily to any factory. Its success is sure, as it appeals to the sporting instinct of the men. But there is still another advantage to it. The power house staff, by approaching the problem of power consumption from the distribution side, gets more intimately acquainted with the labor force, which, after all, is the principal power user. Cooperation in this respect is most desirable, especially now, when all depends on the good intentions of the men.

Hold Your Liberty Bonds

SOME get-rich-quick concerns are endeavoring to persuade patriotic Liberty bond holders, whom they know will not sell outright their Liberty bonds, to turn over their Liberty bonds to these companies as security for a loan and with the money thus borrowed purchase stock in their companies.

A Liberty loan bond is the safest investment in the world, and a prudent man will very carefully investigate any effort to induce him to exchange it for a less safe investment. This lending one money on Liberty bonds as security to purchase stock in the lender's company is in many cases only a thinly disguised method of exchanging stock of doubtful value for Liberty bonds of unquestioned value.

It is a good business and it is patriotism to hold your Liberty bonds.

Marching with the Soldiers

THE United War Work Campaign, which launched a drive for $170,500,000 on Nov. 11, lasting one week, includes seven organizations which are recognized in the United States and in France as among the most valuable aids in keeping up the morale of the army and thereby helping win the war.

These seven organizations, four of which are serving under fire, are marching with the soldier from his own front door, through the training camps at home, on to the Atlantic transports and through the little villages of France, to the firing line. Each one of the seven has found its own special work in the war, and there is no duplicating or infringing. They have been working together many months, with zealous co-operation of the allied armies, and now come before the American people with a co-operative plea to forget creed and race and give for the welfare of the boys in khaki and blue.

The Young Men's Christian Association, which is asking $100,000,000 for its war work, is serving no less than three million American soldiers and sailors in Europe and in the training camps at home. It has between five and six hundred huts in this country and a greater and growing number on the other side. It is keeping a bit of home even at the trenches and under the fire of the enemy. The Y. M. C. A. hut at the front is the soldier's club, his church, his college. It is open to all denominations for service. It is used for musical and theatrical entertainments by the most famous musicians, actors and actresses of the world. It is a place of study and lectures for the boy who would study French or other subjects to be turned to account in after-war days; it is the quiet place where the soldier reads or writes his letters home.

The Young Women's Christian Association, asking for $15,000,000, has gone into the war and into the war industries with the women and girls called to new and perilous work. It has co-operated with the government in the proper housing and care of the women munition makers in this country and has provided recreation centers at all of the twenty-one cantonments. It has established similar centers at munition plants in France and has been so successful in providing necessary rest and recreation that the English government has asked the help of the American Y. W. C. A. in work of that character in England.

The National Catholic War Council, including the Knights of Columbus, asks $30,000,000. The Knights of Columbus have erected clubhouses at the points of embarkation in this country and debarkation in France, and have secretaries assigned to permanent duty aboard transports plying between this country and European ports. One hundred K. of C. secretaries have been ordered to Italy, where 10 buildings are being erected. There is a headquarters building in Paris and permanent clubhouses throughout France and in London. A fleet of motor trucks follow the rapidly advancing armies to provide our soldiers with "service under fire." carrying cigarettes, tobacco, chocolate, writing material, soap, towels and other articles.

The Jewish Welfare Board, which will receive a $3,500,000 share in the United War Work Campaign, officially represents all national Jewish organizations in building up the morale of more than one hundred thousand Jewish men in the army and navy. It has sent its trained workers into the camps and naval training stations. It has erected clubrooms to which soldiers, irrespective of race, can go for rest or for entertainment, where there are libraries with English, Yiddish and Hebrew books, where religious service on Friday evenings and holidays are open to any man who wishes to attend. In the towns near the camps community centers furnish the soldiers with social rooms and sleeping quarters. Jewish chaplains are serving with the army overseas and in the navy. Welfare workers are aiding the families left at home, and among the men in the ranks are performing personal services, distributing gifts and keeping up the boy's contact with his home.

The Library War Service of the American Library Association, which is asking for $3,500,000, has sent overseas during the past year more than a million books for the men of the fighting forces. It supplies a book for the man when he wants to read, and the kind of a book that he wants. It gives its service quickly and directly to the army and furnishes to the soldier who is preparing for after the war the technical books that he needs for his study. The book from the home library, the magazine, the new educational or technical volume bought with money from the public, will circulate through the association to every man in every branch of service.

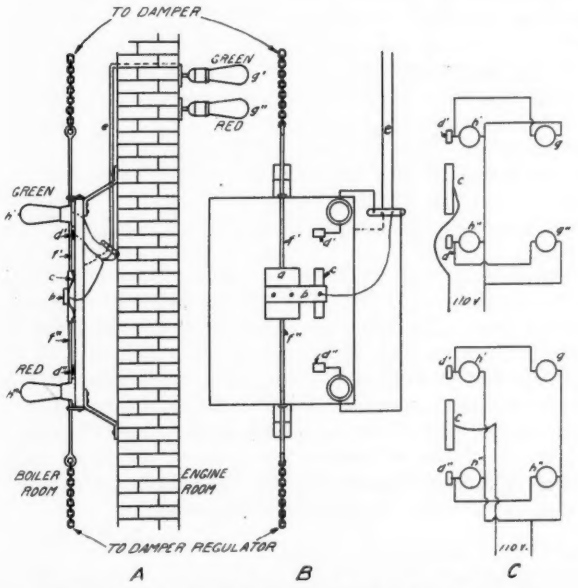
The War Camp Community Service, which is asking $15,000,000, is a nation-wide movement for hospitality keyed to harmonize with the training camp program of the War and Navy Departments. It has a definite, ordered program, supplemented by resources of the folks back home. It invites the soldier and sailor off duty in a strange town to dine and dance and meet the right sort of women. It counteracts the red-light lure with the greater attraction of wholesome recreation and speeds the man in khaki or blue on his overseas way with a keener enthusiasm to fight for a country in which he leaves not bitter, regretful memories.

The Salvation Army's request for its work at home and abroad is $3,500,000. As near the trenches as relief work can be carried, the Salvation Army "hutment" is open, and a woman officer ready to serve hot food to the men under fire. A cook stove with an oven that can bake is certain to be part of the equipment of the little Salvation Army house. In front of it, "lassies" with baskets of food have stood under fire in order to give a hot cup of coffee to the men who are bringing up the ammunition. Truck loads of pies and doughnuts start daily from the bases to the extreme ends of the lines. The women officers have mended the clothing and darned the stockings of the soldiers who come to the hutment for recreation. In this country the Salvation Army maintains hotels near the military and naval bases, and in their clubrooms entertainments fill the soldiers' leisure time.

Damper Regulator Signal

WHILE recently visiting at a power house equipped with nine boilers, I noticed that the damper regulator had a light attached to it and that when the regulator had the damper closed, this lamp was out of sight in a box. Immediately under the box was a red lantern globe so that when the regulator moved to open the damper, the globe became illuminated. One of the men said that it was to notify the firemen to work up the fires.

As this seemed to be a good idea to call the attention of firemen in a small plant the following arrangement was worked out. This is shown at A mounted on the



DETAILS OF DAMPER REGULATOR SIGNALING DEVICE

boiler room wall over the regulator and at first this was the only place where there were lights. Later it was decided to have the two lights in the engine room, so they were connected up as is indicated.

B shows the front view of the apparatus which consists of a board about 18 by 10 in.; a is a piece of steel 2 by 4 by ⅜ in. into which are screwed small rods f′ and f″; this took the place of a section of the damper chain.

It can be seen that with the up-and-down movement of the chain piece a would have a certain travel and act as a switch. Piece b is of red fibre about 4 by 1 by ¼ in. and is held to a by screws. c is a piece of spring brass shown at A bent so that it will roll up on the contact points d′ and d″ which are connected on side of the colored lamps, as shown in the wiring diagram C. The flexible cable connected to c is one side of the line and as can be seen by the upper diagram in C, the other side of the line is permanently connected to the other side of the lamps so that when piece c touches the lower contact point the red lights are lighted and when the upper contacts are touched, the green lights which indicate that the damper is closed tight.

At first it was made to do without the flexible cable by having piece c made flatter and ride over two brass contact points and thus make the connection at each lamp. This gave considerable trouble by burning the contacts and then the lamps would not light, so the method shown was used and the points d′ and d″ are made from pieces of old carbon brushes. Since they have been used, there has been no trouble from poor contacts.

In C are shown two methods of connecting up; the upper one was the original way when the current came from the boiler room side of the wall and afterwards the current came from the engine room lines. Both are good enough to work, however.

The red lights are the most important and with them a man can judge closely about the condition of the fire. As long as no lamp is lighted, it is quite certain that there is fire enough; but if the red light comes on and stays for some minutes, it shows that the fire needs attention and either the engineer or fireman can keep tab on the action of the boiler. G. H. KIMBALL.

Unusual Lubricants

THE PROBLEM of lubrication is by no means simple, and its complexity has been pointed out on many occasions. Lubrication is conditioned by many circumstances.

A spindle from the machine and likewise the bearing in which it is carried have surfaces which consist of circumferential grooves. These are minute, but until the surface more nearly approaches a perfect cylinder a new bearing requires care until run in otherwise until the hills have been abraded to the level of the valleys. It is by no means well known that longitudinal drawfiling with a dead smooth file has, before today, restored running conditions in a bearing which would not behave. For large spindles such treatment is beneficial before erection and is seriously recommended. Since it will restore a bearing which persistently runs warm to a sense of due behavior, it is worth more general adoption.

There are instances where a big job must be kept running at all costs with a hot bearing, and playing a hose on it may dissipate the heat but does not remove the conditions, leading as it does to very rapid wear.

There are a few simple prescriptions, all of them tried and found successful, which have restored a hot bearing to good running condition when shutting down was impossible. Heavy doses of castor oil and minute alternations or injections of distilled water, to induce saponification, is one remedy. Graphite and lubricating oil is another. The worst cases are those in which a steel spindle runs in gunmetal, and there is no remedy to compare with flour of sulphur mixed with lubricating oil; it acts like a charm in most instances, and is strongly advised.

Cast iron sliding on cast iron gives in time a surface skin gloss. Co-efficient of friction is very small, and such skin is not easily broken. When this surface is abraded the conditions are rather startling, for actual red-hot sparks commence to fly in a very short time, and lubricating oil simply burns to a carbon deposit and has no effect whatever. Putty white lead, mixed with lubricating oil, has been successfully used to cure even these conditions. The most unusual lubricant which came under personal notice and experience was used in the thrust bearing of a steamer, and had been utilized there for many years. As is well known, this type of bearing has a large enclosed volume which can serve as a bath. This was filled to axis of shaft with a solution of soft soap in distilled water, about 1 cwt. of soft soap sufficing for six months' use. The entire contents were occasionally changed, and a daily feed of about ½ pt. of strong solution added. The bearing never gave trouble unless a new greaser started to oil it, when its temperature increased in direct ratio to the amount of oil.

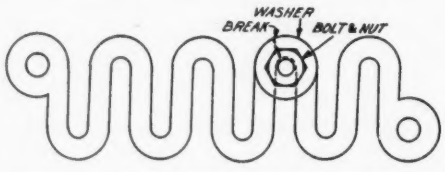
When a bearing gets hot, the metals are in intimate contact, and the normal film is broken down. The remedies noted restore conditions by the interposition of a more durable film between the surfaces. They give an artificial skin to the bruised surfaces and allow gradual restoration of its condition.

Finally, the remedies here noted are known to, and practiced by, marine engineers, and they have before today kept the job running when a shutdown on a lee shore would have meant disaster. This last for the skeptic who may be inclined to doubt their efficacy.

MARK MEREDITH.

Repairing Resistance Grids

HOW OFTEN have you thrown away broken resistance grids, because no adequate means of repairing them suggested itself? The following is the method employed by the writer, and, as there is no mechanical strain imposed on the grids, it has proven a very effective method.



METHOD OF REPAIRING RESISTANCE GRIDS

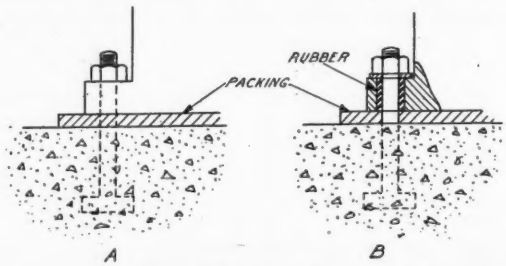
In nine cases out of every ten, the break occurs at a bend in the metal. By placing an iron washer under and one over the grids, and tightening them together with a short bolt or rivet, the broken parts will be held in position and the grids will be as good as new.

Temporary resistance grids can be made with a strip of sheet iron by cutting first from one side to within a short distance of the opposite edge and then repeating the operation from the other side and so on until the strip when pulled slightly by the ends, resembles the regular grids. A hole is bored in each end, and it is ready for use.

MAURICE M. CLEMENT.

Stopping Vibration of Recording Instrument

IN A large pumping station the writer was inspecting he found they experienced difficulty in getting good chart records from their recording meters because of the vibration of the large reciprocating pumping engines. These meter instruments were mounted on concrete bases. The first step was to take a thick strip of rubber, made up of a number of layers of especially live packing, and place it under the instrument, as shown in A, the results were considerably improved, though slight vibration was still experienced. It then occurred to the chief engineer that the remaining vibration was being transmitted to the instrument through the four holding bolts, which were embedded in the concrete base. To counteract this influence, the holes in the instrument base were reamed out sufficiently to accommodate a rubber filler-in piece, and then another rubber washer was placed between the holding nut and the upper side of the case, as a result of which a complete insulation of rubber was secured, as shown in B, and following this the trouble from inobscure records due to vibration practically disappeared.



INSTRUMENT MOUNTINGS TO PREVENT VIBRATION

M. A. SALLER.

Trap Failures: Flywheel for Splitting Machine

ON PAGE 854, Oct. 15 issue, Theo. Haight suggests that "this type of trap should not be used where there is solid matter on a steam pressure in excess of 60 lb."

Bucket traps open wide and don't clog as do float traps, and also bucket traps have blowoffs.

If heavy matter comes along in the water, the logical thing to do is to insert a self-cleaning strainer in the line to trap.

Failures often take place where a greater pressure is carried on the trap than the valve is designed for. For instance, if a strap is operating on 30 lb. and a pressure of 100 is introduced, the excess pressure may cause the disc to remain closed if the trap is not designed for over 30 lb.

By substituting a smaller seat and disc, the trap will work o. k. on the higher pressure. I have sub-

stituted many a bucket trap for a float, but never a float for a bucket. I have found more failures caused by traps being out of level than almost any other one cause.

In placing a trap on the floor, we always build a cement foundation if possible and leave the piping as flexible as possible. If the trap is hung on the wall, we also build a substantial shelf of iron plate laid on forged brackets and bolted to them. Traps, I find, are a necessary evil and with proper attention will save large amounts of steam. It is a wise scheme to keep a trap or two in reserve, and should failure occur simply break unions and cut in new trap immediately, removing old trap for repairs.

We always bypass with valve either side of trap so that the trap may be removed without hindering service. It is well to use one type of trap and carry parts for it, thus facilitating repairs wonderfully.

Just a word about F. M.'s trouble on page 856:

An accumulator in the form of a flywheel will cure the trouble to a very large extent. The flywheel should be placed on the 1 15/16 close to the splitting machine and a new drive will be eliminated. This is not theory but practice. We work this combination and probably employ 50 or more flywheels to help us maintain constant speed when a heavy load is suddenly applied.

Would a 4-in. belt operate a large punch without the heavy flywheel? Would your engine pass the center with ⅛ cutoff or less if the flywheel were only half the weight?

I would suggest that the shaft would transmit more and better power if it operated at a higher speed; 108 is decidedly slow for good practice today. We don't try to make these flywheels govern our engines, but simply assist in overcoming slippage of belts.

The sudden strain of the splitting machine will be taken by the inertia of the auxiliary flywheel, which will perform the same function as a booster on an electric circuit, and when the machine is thrown off the same force should tend to hold the shaft from overspeeding; but, as I said before, better results would be obtained if the shaft were speedier. TOM THUMB.

An Advantage of Frictional Resistance of Packing

THE DIFFERENCE in frictional resistance of two kinds of packings may be occasionally utilized to good advantage. An instance of this was noted in the power house of a large textile plant where there were two 14 by 3½ by 12-in. outside-packed duplex steam pumps used for supplying oil at 1200 lb. pressure to the step bearing of a 500-kw. vertical turbine. Only one pump was required to maintain this pressure and there was no accumulator on the line. Steam was supplied from a 2½-in. main fitted with a Fisher pump governor so arranged as to maintain a constant pressure in the oil line, regardless of which pump was running.

When the pumps were first installed, considerable difficulty was encountered in keeping the plungers packed, and as a result there was much leakage of oil. The proposition was placed before a packing salesman who upon investigation recommended a high grade of long fibre lubricated flax. It happened that when this salesman visited the mills he had with him a metallic packing salesman who strongly recommended a braided copper packing as being better than flax.

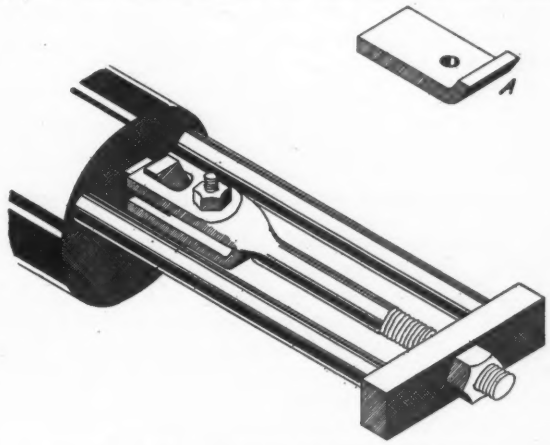
As a compromise, one pump was packed with the flax and one with the braided copper. Each gave very satisfactory results; but it was found that, upon opening the throttle of the pump packed with flax, it would readily take and carry its load, while the copper-packed pump, although under a full pressure of steam, would not move, owing to the greater resistance of the copper packing. If, however, the throttle valve supplying the flax packed pump was slowly closed, even before the gage showed any material drop in pressure, the copper packed pump (with throttle open) would immediately start and take the load. The result, therefore, was the same as if a complex automatic regulating device had been installed to prevent the failure of the step pressure. This condition was maintained for several years and never failed to respond when called upon to act.

C. A. J.

Efficient Key Extractor

AN EFFICIENT and rugged device for extracting headed keys can be quite easily constructed from a suitable size standard bolt and a piece of flat stock.

The head of the bolt is cut off and a section of the body of the bolt is drawn out thin and flat and offset



DETAILS AND ASSEMBLY OF KEY EXTRACTOR

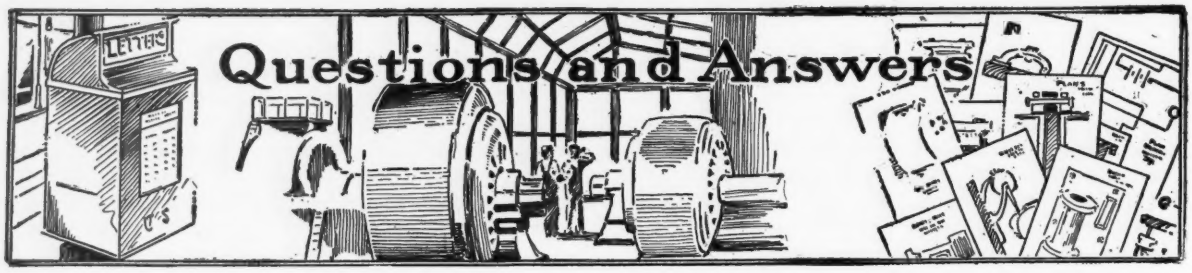
slightly. A hole is drilled and filed in this to take the key head. A small strap is made as shown at A; a hole is drilled in both parts to take a clamping bolt. The device is used as shown in the sketch; a cross-head and two pieces of suitable length pipe complete the outfit.

C. H. WILLEY.

Sheet Zinc for Packing

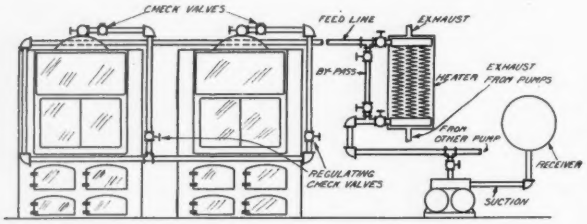
THE ENGINE at a sawmill (doing government work) started blowing steam at the crank end of the cylinder and a number of different packings were tried but without success. The engineer, seeing some sheet zinc in the warehouse, decided to try the zinc for packing the engine; he took the zinc to the mill and fitted a couple of thicknesses of it for gaskets; the blow ceased and after running a few days there was no leakage at all.

Later a zinc gasket was put on the cylinder head of a steam tractor when the other packings on hand would not hold and, as in the former instance, the zinc gave entire satisfaction. A. NEIL.



Why the Pound?

I WOULD LIKE a little help on a matter concerning my plant. I have a 2-in. brass feed line feeding my boilers through a Riley multi-coil heater, and the line pounds quite badly at times. I am using a 5¼ by 3½ by 5-in. Snow duplex pump (steam), using water from a receiver where all the returns come to, from the heating system. The pump is controlled by a governor and the receiver is placed above the pump, suction in bottom. I use make-up water from a line tapped into a header from service pump and can use city pressure if needed.



ARRANGEMENT OF TROUBLESOME FEEDING EQUIPMENT

The pump seems to work all right and keep up the supply. Boiler pressure carried is 90 lb.

I also have a 5¼ by 3½ by 5-in. Blake-Knowles duplex, which does the same thing whenever I change off. Can you suggest anything to stop this? Would say I have attached an air chamber on the Snow pump, but does not stop trouble.

The pound seems to be on the line in front of the boilers and on the riser to each boiler. On account of the construction of the building and the height of the boilers, there are more turns than I would wish.

C. W. A.

What Caused Drop in Water Level?

WE HAVE a battery of two h.r.t. boilers here and they were both running every day, connected to one steam main. This is a wood working plant, and there is no night watchman, so we always let the fires out over Sunday. Monday morning the fireman going on duty found a couple of grate bars down in No. 1 fire box. Not having time then to put them in he got up a full head of steam on No. 2 boiler, leaving No. 1 fire box cold, so that he could put them in later after getting started. He got up a full head of steam, 120 lb. pressure. The engineer started the engine 5 min. before whistle time. The engine ran all right, so he went to the fire room to blow the whistle, and at first it sounded as usual, then it commenced to sound as if somebody was shutting a valve in line, then all at once when he was looking at the steam gage the pressure dropped from 110 to 60 lb. and then there was a great rush of water out of No. 2 boiler and water was lowered from two gages to the very bottom of the glass.

The water did not go through the engine, neither did it go out the whistle. I think there was some water went over into No. 1 boiler, but not as much as left No. 2. There was a vacuum in both boilers when fire was started; they were not vented. I would like to hear from readers their opinions as to what caused this drop in water leved.

B. H. B.

Auxiliary Exhaust Calculations

HEREWITH is a problem which has caused considerable argument and which I would like to have you solve for me. The unknown quantity in our case is the amount of the exhaust steam from the auxiliaries that has been utilized to heat the feed water.

The following example is taken from our daily log sheet:

Water evaporated, 1,615,000 lb.

Temperature water from heaters, 200 deg. F.

Temperature water to heaters, 77.5 deg. F.

We are using the Cochrane open feed water heaters. As opinions seem to differ somewhat regarding the correct solution of this problem, I will greatly appreciate any information you can give me regarding this matter.

I would also like to have your opinion on the following method of determining the temperature to which feed water is raised in open heaters. This is taken from Gebhardts' Steam Power Plant Enginering, as follows:

Let H represent the total heat of steam corresponding to the pressure in the heater; t_0 the temperature of the water entering heater; t the temperature of the water leaving heater; and S the ratio of exhaust steam to the feed water, by weight.

Then, allowing a loss of 10 per cent due to radiation, etc., 0.9 S (H—t+32) will be the number of B.t.u. given by the exhaust steam to each pound of feed water, and $(t - t_0)$ will be the number of B.t.u. absorbed by each pound of feed water. Do you not think allowing 10 per cent as a loss due to the radiation is somewhat excessive?

J. A. L.

A. The method outlined by you seems to be quite right for determining the amount of heat given up by exhaust steam, and the amount taken up by the feed water.

You do not state the pressure at which your heater operates, but we assume this to be atmospheric. The temperature difference for the feed water would then

be 122.5 deg., which multiplied by the water evaporated, 1,615,000 lb., would give approximately 197,500,000 B.t.u.

At 15 lb. per square inch pressure, the total heat will be 1152.2, and this would make the heat given up per pound of exhaust steam, 984.2, using the method you have outlined. Dividing the heat taken up by the water, by this quantity, gives approximately 200,800 as the pounds of steam condensed in the feed water heater.

Of course, if you add 10 per cent for radiation, you would have 220,880 lb. of steam as that going through the heater. I think the allowance of 10 per cent for radiation is ample. The highest estimate I have seen for percentage radiation in a piping system is 5 per cent, which is in a bulletin issued by the University of Illinois Experiment Station. Other estimates run as low as 1¾ per cent.

Reducing Space in Rear of Boiler

IN CONNECTION with my boiler which is provided with 42 2½-in. tubes and a 36-in. grate the space between the rear head and the brick wall is 32 in., more than ordinarily allowed boilers of that size. I have a forced draft blower and the stack is only 18 in. in diameter and 50 ft. high.

Would reducing the space between the boiler and the rear setting wall from what it now is to 11 in. bring about more satisfactory results? W. K.

A. We do not see any advantage in reducing the space between the back end of the boiler and the brick wall. So long as this space is large enough to give free flow of the gases from the combustion chamber around into the tubes, extra space does no harm, except so far as it increases somewhat the radiation from the outside of the boiler setting.

This will not be of sufficient consequence to have any great effect on the operation of the boiler; in fact, if you are burning bituminous coal, the extra space would be an advantage in giving more time to complete the combustion.

Estimating Ammonia Leakage

I HAVE two freezing tanks containing 10,400 ft. of 1¼-in. pipe and two 4-in. headers.

On account of the carelessness of ice pullers, I have had four break-downs in these tank coils since they were fully charged. This is a flooded system and the loss consisted of the entire capacity of the coils and always occurred on the pipe threads clear of the flanges on the bottom pipe.

About how many pounds of ammonia do you estimate I lost? J. A. P.

A. It would be a good deal of a guess to say just how much ammonia you lost from your coils by a break which took out all the ammonia in them. In the flooded system, the ammonia may be carried at almost any height in the coils, and the level at which the ammonia happened to be standing would be the deciding factor in determining what the loss was.

For 1¼-in. pipe, it takes 96.25 lineal feet of pipe to contain a cubic foot. Your 10,400 ft. would, therefore, contain 108.2 cu. ft.

You do not give the length of the 4-in. headers, but for 4-in. pipe it takes 11.3 ft. for a cubic foot, and if you had, say, 22 ft. of 4-in. pipe, it would amount to practically 2 cu. ft. of ammonia. This would give 110 cu. ft. total.

At 10 deg. F., ammonia will weigh about 40.2 lb. per cubic foot, so that 110 cu. ft. would give 4422 lb., which would be lost from the 22 ft. of 4-in. headers and 10,400 ft. of 1¼-in. pipe, if the pipe and headers were full, which they probably were not.

In connection with this matter, you should have an inlet and outlet valve on each coil leading from the header, so that in case of a break in the coil, that coil can be shut off from both inlet and outlet headers; or in case of a break at the header, all other coils can be shut off, and the inlet and outlet to the headers shut off, thus losing only the ammonia in the broken coil and the headers.

Compressor Horsepower Requirements

WE HAVE an 8-ton York dry compression refrigerating machine operated by a 20-hp. gas engine running at a speed of 120 r.p.m. This set has given us perfect satisfaction for our cooling purposes; but, due to the fact that the gas supply is inadequate, we are desirous of using an electric motor instead of the engine. What size of machine should we get?

I carry 15 lb. back pressure and the high pressure varies from 175 to 190 lb. A. W.

A. We judge that a 20-hp. motor will be about right for driving your 8-ton compressor. With a back pressure of 15 lb. and a head pressure of 180 lb., you would require about 1.15 hp. per ton for compressing the ammonia.

From an 8-ton compressor, this would require 9.2 hp., and allowing for a 50 per cent over-all efficiency of the compressor, this would mean 13.8 hp. to drive the compressor. With an efficiency of 75 per cent for the motor, this would give 17.25 hp. for the motor, and allowing a 20-hp. motor would give you ample margin to take care of overload.

The Barometer

WILL YOU kindly explain to me the construction and operation of the ordinary barometer? W. J. F.

A. The barometer is simply a mercury pressure gage for indicating atmospheric pressure. It consists of a glass tube filled with mercury and inverted, with the lower end immersed in a dish of mercury, so that there is a complete vacuum in the upper end. The height of the column of mercury supported by the atmospheric pressure shows the amount of the pressure. This for ordinary conditions at sea level is 30 in. The gage pressure as shown on the ordinary steam gage is the pressure above atmosphere, so that to get the absolute pressure, which we use in making computations, we must add to this gage pressure, the pressure as shown by the barometer. For approximate calculations, this is figured as 15 lb. For accurate calculations, a barometer reading should be taken and the atmospheric pressure calculated from that, on the basis of 0.491 lb. pressure for each inch of mercury.

POWER PLANT ENGINEERING

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Power Plant Loyalty

Coal means Victory. Without it there could be no steel for ships, guns, tanks, railroads, docks or other essentials of a modern equipment for war. Without it clothing, hospital supplies or munitions could not be made in adequate amounts to supply our fighting men. Even though they were made, without coal neither the supplies nor the men could reach the fighting front where the struggle to overwhelm tyrannical autocracy is now going forward to ultimate complete success.

Our boys with our allies have won glorious victories, and are still on tiptoe for more success. We are right to exult with them and to cheer for them. But, though less picturesque, we of the power plants have a right to much satisfaction in the loyal effort of our own calling, that is helping to make possible their achievements.

The Fuel Administration reports that through the co-operation of industrial power plants a saving at the rate of 7,000,000 T. annually has been effected during the last six months, without reducing production in the factories. This has been done largely by careful firing and management of plants, without expense of consequence to plant owners. Plants are reporting savings in fuel as high as 25 per cent, the average running from 10 to 15 per cent, and the largest savings being in Illinois, Michigan, Minnesota, Wisconsin, Missouri, Massachusetts, Pennsylvania, New York and Connecticut.

The means by which these savings have been accomplished have been described in Power Plant Engineering, and include reports, inspections, addresses, public meetings, advice of experts and the mobilization of engineers and engineering societies to focus attention on power plant conditions and secure improvement where possible.

Details of the methods used by Mr. Harrington, Administrative Engineer for Illinois, are being furnished to readers, and it is by the use of these and similar methods that the saving, estimated by the Fuel Administration at 25,000,000 T. of coal, is being made.

Power Plant Engineering takes pride in its work to assist you, the members of its family, in your loyal campaign for fuel saving, and congratulates you on the success of your effort. It is as real and vital a part of carrying on this war for freedom as is the building of ships, the driving of transport trains or even the charging of machine gun positions; each engineer who is earnestly endeavoring to keep his fuel consumption to a minimum has a right to be proud of the part he is playing in supporting our men at the front. And at the same time he can take satisfaction in the thought that he is placing his plant and his industry in better position to meet the economic struggle which will come during the reconstruction period, after the Hun has been taught the needed lesson that war for conquest and fiendish brutality have no place in the modern world, and the armed fighting is over.

For many years the world will need careful economy to replace the wastage of war. The power plant man will have his effective place in helping that work, as he has had in winning the victory at arms.

We are soldiers of peace as well as of war, and what we are learning now of effective economy will be of inestimable value for all time to come.

Power Plant Economy Number

THE JAN. 1, 1919, number of Power Plant Engineering has been planned to meet the special needs of power plants at this time and to help them in conserving fuel, machinery and supplies.

The plan includes taking up in detail the equipment of the plant, methods of making a survey to discover where improvement is possible, directions for tests to discover losses and keep track of economy, instruments needed for tests, and those desirable to assist in best operation, how to get standards for comparison with the performance of the plant, so as to know when satisfactory results are being obtained and where to look for causes of poor performance.

Lastly, suggestions will be given of how different losses may be eliminated by overhauling apparatus, rearrangement of plant and connections and adding such apparatus and appliances as may be needed.

TESTING THE COAL. The reader will be shown how to get a representative sample, to make a proximate analysis and to determine the heat value of this coal; also, how to check his results by government tests when the origin of the coal is known.

WHAT'S IN THE WATER? Tests for hardness will be given covering temporary and permanent hardness, scale-forming material, matter in suspension, acids, alkalis, oils, etc. The effect of various impurities on the boiler will be shown, and how to estimate the treatment needed to remove them.

FEED-WATER HEATER. What is a reasonable transmission of heat from steam to water? How much heat is available for heating the water? How much is being utilized? Is the heater large enough? Is it doing what it should? If not, why not? These are the questions the Jan. 1, 1919, issue will enable the engineer to answer.

PUMP TESTING. This section deals with the investigation of reciprocating and centrifugal pumps to determine their capacity, their actual performance, the power taken and that utilized in pumping, and what changes may be made to improve the load carried and the efficiency.

A BOILER'S SECRETS. The engineer will be told how to go over his boilers minutely to make sure that soot, scale, air leaks, poor draft, bad setting, leady baffles, wrong firing and other irregularities are not working evil in his establishment. Also what to keep track of, how to do the weighing, measuring and testing, how to keep records, to study them and draw conclusions, what equipment should be on the boilers, how it should be installed and regulated, how to burn poor coal with economy.

GOOD AIR SUPPLY. First, the draft must be right; next, the air must be right; then, how much power should it take to supply that air. The engineer will be shown how to estimate these.

OVERHAULING THE PIPING. Piping should be inspected for leaks, bad insulation, bad turns, useless valves, idle dead ends. It should be tested for undue pressure drop, too much condensation, collection of water. It should be made tight, covered, straightened, simplified, enlarged if necessary, put in shape to transmit the steam, brine or water to the best advantage. This section shows the way.

GOING OVER THE ENGINE. This section takes up the thorough inspection, the testing by indicator diagrams, comparison of initial and exhaust pressures with boiler and condenser, getting at steam consumption, and comparison with standard performance of similar engines under like conditions.

GENERATOR AND MOTOR TESTING. The points to be looked after in making the inspection of generators and the data needed for good operation will be explained, also how to make certain that such operation is maintained. For motors proper maintenance of speed to insure maximum output of the driven machinery, and cutting off of current when the motor is idle, are additional precautions necessary.

THE STEAM TURBINE. This section will show how to go about a careful inspection. Underloading, overloading, bad piping may result in unnecessarily large demand for steam. Testing of these points and how to plan operation to get best results will be taken up and fully explained.

CONDITIONS OF CONDENSERS. Going over the condenser to detect leaks, bad condition of tubes, nozzles, joints, baffling and piping is the first step, and cautions as to how to conduct each part of the examination will be given. Then comes the testing to determine heat transferred, water used, proper size and loss of vacuum between condenser and prime mover.

POWER WASTED BY SHAFTING. The way to inspect shafting will be stated, with cautions as to the points to be watched, how to determine the power wasted, and how to estimate the loss that may rightly be allowed for any given system.

ELECTRIC TRANSMISSION LINES. Insulation may be poor, allowing leakage to ground or between lines. Transformers may be running idle or at low load over long periods. High resistance may be introduced by poor switch contacts, poor connections or small wire. This section will tell how to bring line losses to a minimum and guard against breakdown of service.

COMPRESSING AIR EFFICIENTLY. It's easy to neglect leaks in a compressed air system. There is no evidence except perhaps a little hiss, no moisture collects, but power is being wasted. How to make the system the most efficient should be the object, and is explained in this section.

ECONOMICAL AMMONIA COMPRESSION. The ammonia compressor has many possible sources of loss through incorrect head and suction pressure, dirty lines, leaky valves and pistons, that will not be evident to the nose. Testing must be resorted to, and how to do it will be told in this issue.

Each subject will be treated by an expert of long experience in that particular part of the power plant field. His statements can be relied on as having the backing of being used successfully, and his advice and directions can be followed with implicit confidence. The issue will be found of immense value to those fortunate enough to come into possession of it, and if used as a guide will result in the saving of thousands of tons of coal in the power plants of the country.

Fuel Administration's First Weekly Letters

AS pointed out in the Nov. 1 issue, the Administrative Engineer for Illinois was planning to send weekly letters to power plant owners. Following are copies of the first two letters sent out. The first is a general introduction to the series and the second is a questionnaire which will aid in the solution of the coal storage problem.

FIRST GENERAL LETTER TO ALL FACTORY COMMITTEE CHAIRMEN IN THE STATE OF ILLINOIS

IN ORDER to bring to your attention the matters which must be looked after in the improvement of your plant efficiency, I shall send you, through your district chairman, a series of letters on various interesting topics.

When you get these letters, please carefully read and preserve them and immediately study your plant with the object of finding out just how you stand in reference to the subject of the letter.

The week set aside for each subject should be devoted to a very careful examination of your plant in reference thereto, and you should take immediate steps to improve the conditions if improvement is possible.

Attention to the matter of plant improvement will not only increase your efficiency and save you the coal that you are now wasting, but will reduce the total fuel required for the state of Illinois and permit of active prosecution of our war activities.

Yours for conservation,
JOSEPH HARRINGTON, Administrative Engineer.

COMMITTEE CHAIRMEN IN THE STATE OF ILLINOIS

PLEASE answer the following questions and mail your answers direct and as soon as possible to Prof. H. H. Stoek, Department of Mining Engineering, University of Illinois, Urbana, Ill.:

1. What kind of coal was stored?
2. What size of coal was stored?
3. What amount of coal was stored?
4. State from what mining district and, if possible, from what mine the coal came.
5. The size of pile—Depth; length; breadth?
6. Describe the method of storing.
7. Have you had any difficulty from fires in your coal pile?
8. How much, if any, of the coal was destroyed by this fire?
9. What, in your opinion, was the cause of the fire?
10. What evidence have you upon which to base this opinion?
11. How long had the coal been in storage when the fire was observed?
12. Was the coal actually ablaze or only smoking?
13. Whereabouts in the pile did the fire start?
14. How was the fire controlled or extinguished?
15. Was any attempt made to ventilate the pile? If so, how?
16. Was there any damage to adjacent structures?

Information furnished by:

Company .....

Address .....

City and State.....

General remarks:

Over the Top in the Liberty Loan

THE manner in which the firms and organizations in engineering industries went "over the top" in the fourth Liberty Loan is especially gratifying to engineers. We have not the detailed figures for other cities, but in Chicago the quota of the engineering section was exceeded by 20 per cent.

In Pittsburgh, the figures from the Westinghouse industries showed subscriptions of $6,500,000, of which $5,500,000 was taken by employes of the Westinghouse Electric & Mfg. Co. and its subsidiaries. Methods used during the campaign were noonday and evening meetings, at which four bands from the employes, a community chorus of 200 voices, a male chorus of 20 and several quartets and soloists aided in arousing enthusiasm and maintaining interest. A large Victory arch was erected on 5th Ave. and dedicated with appropriate ceremonies, Edward O. Tabor delivering the address. On Oct. 4 a parade was held at East Pittsburgh at noon, those departments which had subscribed 100 per cent being especially featured. Smaller parades daily, and the spirit of loyalty shown demonstrated that the people of the Westinghouse organizations are second to none in their love of liberty and determination to stand back of the men in National service.

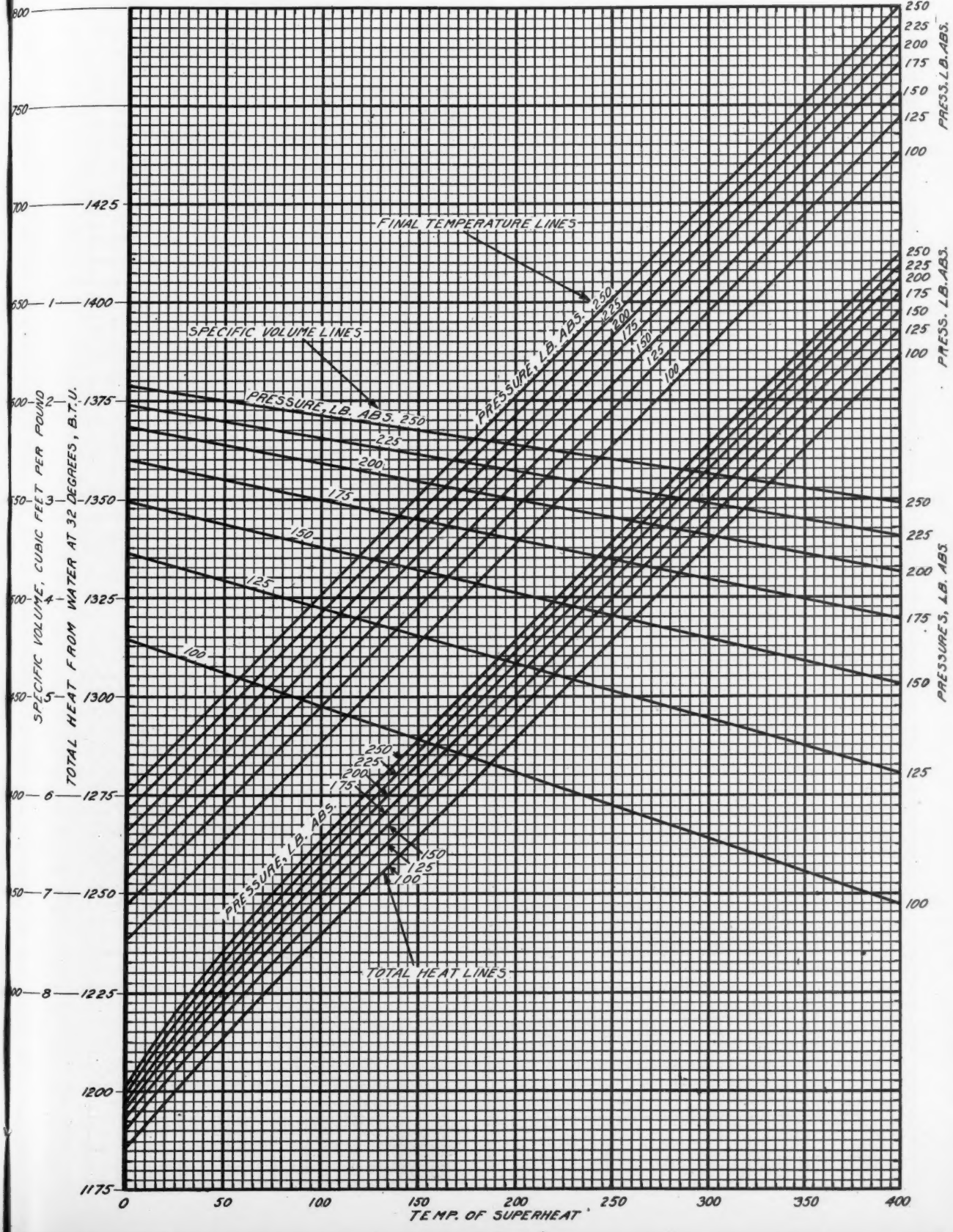
At Ft. Wayne, Ind., S. F. Bowser & Co. used somewhat different methods, but with equally gratifying results. To give publicity to the County Campaign, the services of Art Smith, a government aviator from Dayton, were secured. He was formerly a machinist in the Bowser works, though he has been flying for 9 yr. Flying over the city and factory at the noon hour, he performed all the "stunts" known to aircraft in his DeHaviland Four, and landed at the Ft. Wayne Landing Field.

At the plant of S. F. Bowser & Co., the campaign was conducted strictly on the Volunteer basis. In previous campaigns a soliciting squad was organized, with captains and lieutenants in each department. In the fourth campaign, everyone was urged to buy, without being personally solicited, as many bonds as possible, and three booths were set up in the plant to receive subscriptions. Every man and woman was permitted to work out his or her problem and be the sole judge of the amount taken. The campaign closed the night of Oct. 1, and it was found that the collective conscience of Bowser employes had been so seriously at work that 1495 subscriptions were entered from the home plant, and the amount was larger per person than in the third campaign.

Branch officers and salesmen of the Bowser Co. made their subscriptions to their own local organizations, so that the buying at Ft. Wayne was solely from home office and factory forces.

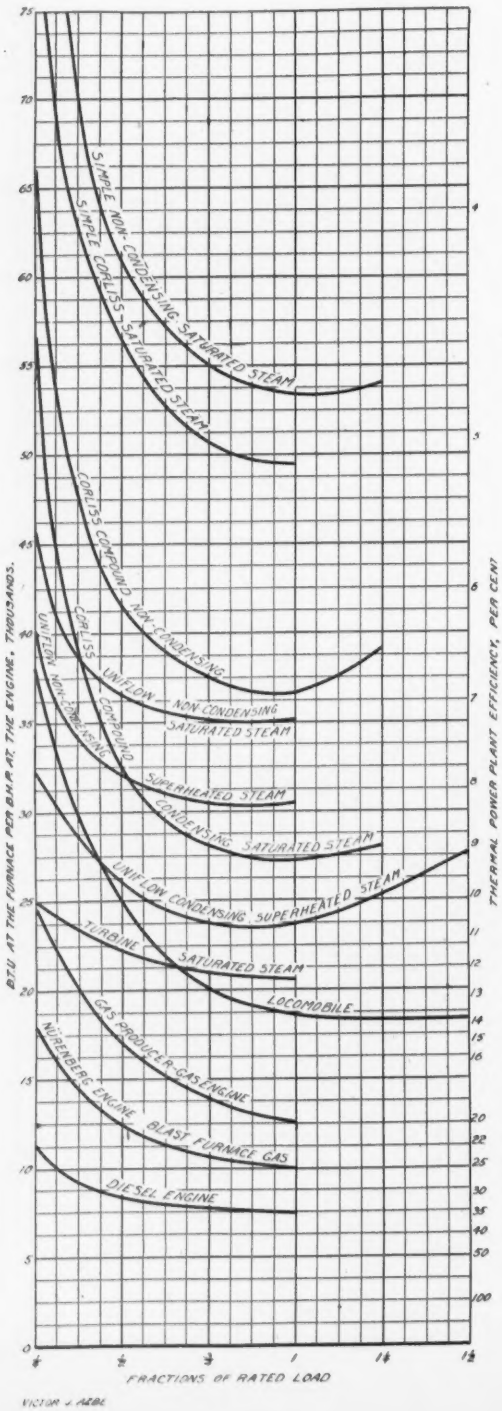
POWER PLANT ENGINEERING

SUPERHEATED STEAM CHART

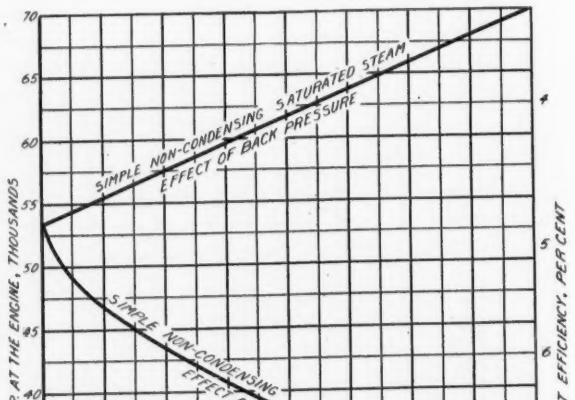


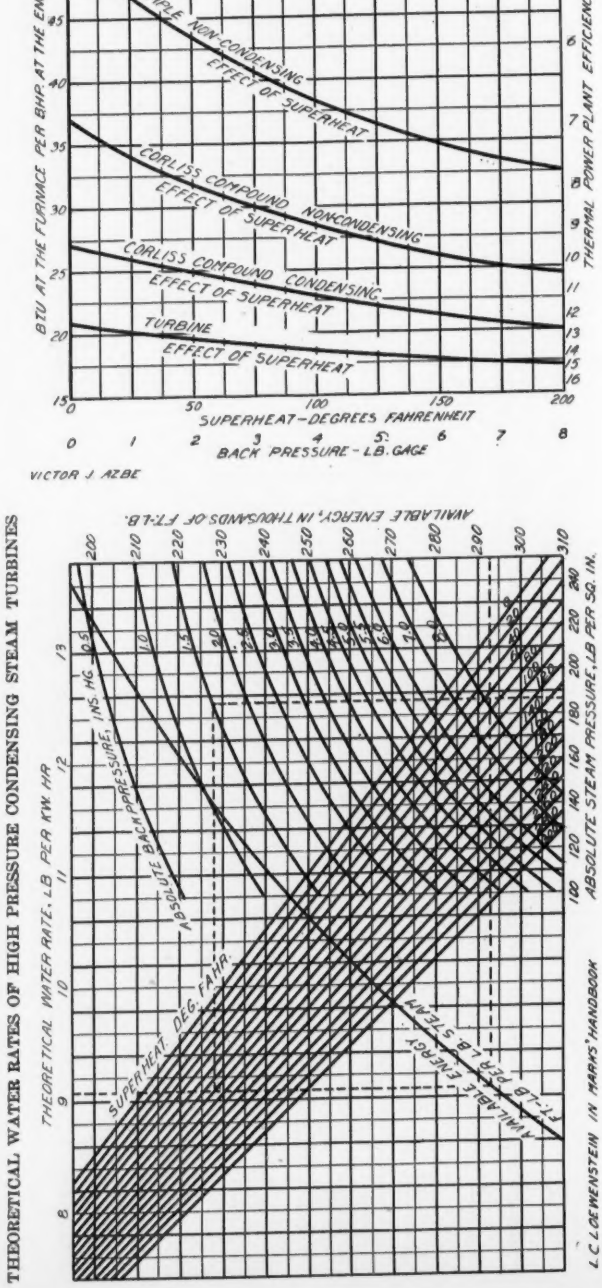
RELATIVE EFFICIENCY AND HEAT CONSUMPTION OF VARIOUS POWER INSTALLATIONS

Based on the assumption of 70 per cent boiler efficiency, 3 per cent for boiler feed pump, auxiliary steam for condensing engines 5 per cent of total, feed water temperature 200 deg. F. heated by exhaust steam or economizer.



EFFECTS OF SUPERHEAT OR BACK PRESSURE ON POWER PLANT EFFICIENCY




THEORETICAL WATER RATES OF HIGH PRESSURE CONDENSING STEAM TURBINES
THEORETICAL WATER RATE, LB. PER KW. HR.
AVAILABLE ENERGY, IN THOUSANDS OF FT.-LB.
ABSOLUTE STEAM PRESSURE, LB. PER SQ. IN.
ABSOLUTE BACK PRESSURE, INS. HG
SUPERHEAT DEG. FAHR.
AVAILABLE ENERGY FT.-LB. PER LB. STEAM
L. C. LOEWENSTEIN IN MARKS' HANDBOOK

Books and Catalogs

HANDBOOK OF MECHANICAL AND ELECTRICAL COST DATA, by Halbert P. Gillette and Richard T. Dana, New York; First Edition; 1750 pages, illustrated, 4¾ by 7 in., flexible binding, $6.

The authors have borne in mind particularly the practical requirements of designers, appraisers, chiefs of construction, superintendents of operation and engineering students. Following is a list of the different subjects treated: General economic principles, various subdivisions of costs, tables of overhead costs, depreciation, repairs and renewals, economic principles of building construction, of office buildings, steel frame factory buildings, reinforced concrete buildings; cost, depreciation of plant machinery, buildings, cost of operation and maintenance of chimneys and in general the cost, operation, maintenance and depreciation of the entire field of electrical and mechanical equipment of industry.

Owing to the fact that the levels of wages and prices of material change frequently, the authors have gone to considerable pains in the introduction, Chapter I, to show how cost data are usable even where wages and prices have changed since the compilation of this book. The selection of prices and expenses that existed prior to the world war and in most cases the data is presented in such a way that relatively little work will be involved in applying them to existing conditions in any part of the United States by following the methods outlined in Chapter I.

In Chapter VI we find the subject of fuel and coal handling completely covered. A few of the subjects are, calculation of steam, coal required by power plants, economy to the consumer resulting from the purchase of coal under specifications, economic points in the selection and purchasing of coal, coal size and B.t.u. per dollar cost, coal burned per square foot, coal size and comparative cost of coal and oil fuel for railroads, comparative size of smokestack neeessary with fuel oil as compared to coal, comparative qualities of oil and coal consumed for the same quantity of power produced, etc.

Chapter VII is entirely devoted to steam power, covering economic value of furnace efficiency, cost of producing power, reduction of steam costs in boiler house by elimination of human labor, saving in steam cost due to superheat, increasing the economy and capacity of steam boilers by using forced draft, reduction in coal cost by the use of a balanced draft system, annual saving from the use of soft water in 1000-hp. boiler plant, labor cost in a compound condensing steam plant, choice of power for textile mill, cost of steam and electric power for operating flour mills producing 5400 bbl. of flour per year. Power maintenance, cost of a 12-story loft building, average costs of installing and operating coal burning steam plants. Floor area occupied by fire tube and water tube boilers, and numerous other subjects for the steam plant.

Chapter VIII is devoted to internal combustion engines and gas producers going into full details as to the cost of installing the economic factors of gas power, mechanical and thermal efficiency of internal combustion engines, cost of power generation and small plants, etc.

Chapter IX covers hydro-electric plants, unit basis for first cost estimates of hydro-electric plants, cost of a 1400-kw. hydro-electric plant, cost of hydro-electric power plants from 100 to 1000 hp. and for 10 to 40-ft. heads.

Comparison of kw. cost of steam and hydro-electric power, data necessary in purchasing water wheels, cost of water wheels and turbines, etc.

Chapter X, first cost and operating expenses of complete electric light and power plants. Chapter XI, overhead electrical transmission and distribution, cost of wooden poles, detail cost of preparing and setting wooden poles, value of treating poles and equipment, cost of setting poles by block and tackle, detail cost of cross-arms, etc.

Other chapters deal with underground electric transmission and distribution, lighting and wiring, factory illumination cost, current requirements for lighting, comparison of cost of lighting by various systems, cost of arc lighting, efficiency of arc lamps, cost of lamps, labor cost in interior construction, etc.; belts, shafts and motor drives; compound air compressors of various kinds; gas plants, cost of manufacturing; pumps and pumping; conveyors, hoists, cranes and elevators; heating, cooking, ventilating, refrigerating and ice making; electric railways, detailed apparatus of various railways; miscellaneous prices of various mechanical and electric apparatus, cost of tool operation in engine manufacturing, etc.

THE TIME is now ripe for more centralized, concerted work on a program of economic reconstruction after the war, says a report made public recently by the Bureau of Foreign and Domestic Commerce, Department of Commerce. It is the first of a series of reports to be issued on this subject and is devoted to the plans under consideration by other countries, especially as they bear on future foreign-trade developments.

"The outstanding fact under observation," states the report, "is the recognition in every land and by all statesmen of the problem called 'economic reconstruction.' But of more immediate importance is the fact that England, France, Italy, Germany and Austria are making preparations to resume their peaceful economic life, with improved facilities for foreign trade, with a national supervision of the use of natural resources for the benefit of their own citizens, and with assistance from the state."

Attention is called to the achievement of our own Government in preparing for after-war conditions, such as the building and organizing of a huge merchant navy backed by large and efficient shipyards and docks, the Webb-Pomerene export trade act authorizing exporters to combine for export trade, and the leeway in foreign-trade banking now possessed by the Federal Reserve Board and banking system. All told, there has been a very considerable amount of effective work done looking toward the future, but much remains undone and the bureau is issuing this analysis of European tendencies as a guide, although calling attention to the fact that each country has its own peculiar problems that it must work out for itself.

"In England," says Mr. Cutler, Chief of the Bureau,

in his introduction, "judging from present comments on the work of the Committee on Commercial and Industrial Policy after the War, any present attempt to lay down complete and binding policies regarding the future is now recognized as a waste of effort. What is more important is the assembling of facts, taking the basic step to improve our educational, research, and promotive organizations and contributing to clear thinking as to the questions involved. Sooner or later we must have a definite program in which work and plans for the future based on known conditions affecting our future may be co-ordinated. I personally feel that the time is now ripe for some more centralized, concerted work to that end."

The report is entitled "Economic Reconstruction," Miscellaneous Series No. 73, and is on sale at 10 cents a copy by the Superintendent of Documents, Government Printing Office, Washington, D. C., and by all the district and co-operative offices of the Bureau of Foreign and Domestic Commerce.

LEATHER BELTING is a material which has not been standardized, because of the fact that, in years past, most belting has been made to order, and different belt users had no means of knowing how their results in effectiveness of transmission or length of belt compared.

Graton & Knight Mfg. Co., of Worcester, Mass., has taken up this question, and while this company has for some time been manufacturing standard grades and brands of belting, they have in this book described a standardized series of belts adapted for practically every purpose.

The book explains, first, the value of standardization of belts, the same as of other machinery parts, and shows how to apply standardized belting to any manufacturing plant. The brands made by the company are then shown and described, including recommendations for their use in all principal industries, and a further section devoted to mechanical rules and tables shows how to find out the width, thickness and brand of belt to be used for any given set of conditions and for any required horsepower; also, how to determine the length of belt that should be ordered, whether it be of the endless type to be joined with lap ends or square ends. The section on standards to be used for leading industries is particularly valuable, as it is quite definite as to the proper belt for different conditions of service, and thus makes the matter of selecting a belt for any given condition extremely simple.

The object of the book is to show belt users why belting can be standardized, the economy to be derived in purchasing on this basis, and to assist in placing belt buying on a more practical basis than heretofore. The book can be had from the Graton & Knight Mfg. Co., Worcester, Mass.

CATALOG X-4, just issued by Lagonda Mfg. Co., Springfield, Ohio, is a somewhat general 40-page catalog giving full description of the company's boiler tube cleaners for both water and fire tube boilers and cleaner accessories, and briefly describing other boiler room specialties.

The company will be glad to send a copy to anybody interested.

CHEMISTRY IN OVERALLS is the subject of a booklet describing the work of the analytical laboratory of Arthur D. Little, Inc., Cambridge, Mass., in making chemical analyses, engaging in industrial research and solving problems in manufacture.

RHEOSTAT and compensator mechanisms, operating handwheels and accessories for use with standard G. E. rheostats, are listed in General Electric Co.'s Bulletin No. 47,702.

CATALOG NO. 40 of The Gwynn Engineering Co., Pittsburgh, Pa., illustrates and describes the Gwynn gas burning equipment in connection with different types of boilers and furnaces.

FROM TATE-JONES & CO., INC., Pittsburgh, Pa., we have received the company's latest catalog on heat treating furnaces of large capacity.

FEATURES of Blackmer rotary hand pumps are discussed in a circular just issued by Blackmer Rotary Pump Co., of Chicago.

BUILDING A BUSINESS is the title of a booklet presenting a life story of L. S. Starrett and published by The L. S. Starrett Co., Athol, Mass.

STOCK LIST OF CUTTERS was lately received from The Cleveland Milling Machine Co., Cleveland, Ohio.

Trade Notes

THE NORMAN W. HENLEY Publishing Co. announces that Mr. Henley has become connected with Henry Carey Baird & Co., Inc., of Philadelphia, and the books heretofore handled by the Norman W. Henley Publishing Co. will in future be handled by Henry Carey Baird & Co.

THE BARBER-GREENE CO. announces the strengthening of its organization as follows: F. E. Smith, Chief Engineer, formerly of the Engineering Department of the Stephens-Adamson Mfg. Co., of the Granby Mining & Smelting Co., and the American Zinc & Chemical Co.; Geo. C. Sanford, Superintendent, formerly of the Elevator Supplies Co., and of the Otis Elevator Co.

THE CHICAGO PNEUMATIC TOOL CO. announces the appointment of A. M. Brown as District Manager of Sales, 1740 Market St., Philadelphia, succeeding G. A. Barden, who remains in Philadelphia as sales representative for the company.

For some time past Mr. Brown has been located in the New York offices of the company as Assistant Manager Compressor Sales Division.

MORRIS & CO., of Chicago, have just placed order with Locomotive Pulverized Fuel Co. for equipping its steam power plant at Oklahoma City, Okla., with the complete "Lopulco" system for crushing, drying, pulverizing and burning coal. The company expects to use native coals and to make use of Texas lignite. The power plant contains seven Edgemoor boilers having a total of 3100 hp., all of which are to be equipped.